R Series, Vol. II, No. 1 September, 1938

PALESTINE JOURNAL OF BOTANY

Rehovot Series

(formerly the Palestine Journal of Botany and Horticultural Science)

EDITED BY
H. R. OPPENHEIMER and I. REICHERT
Agricultural Research Station, Rehovot, Palestine

CONTENTS

Dedicated to the memory of OTTO WARBURG

REHOVOT

PALESTINE JOURNAL OF BOTANY

appears in two series

THE JERUSALEM SERIES (J)

edited by the staff of the Department of Botany of the Hebrew University, Jerusalem (Director: A. EIG). Four issues of JERUSALEM SERIES appear during the year, each number bearing the date of publication. The size of the annual volume of JERUSALEM SERIES varies from 300 to 400 pages.

THE REHOVOT SERIES (R)

edited by H. R. OPPENHEIMER and I. REICHERT, Agricultural Research Station, Rehovot, Palestine. Two issues of REHOVOT SERIES appear during the year, each number bearing the date of publication. The size of the annual volume of REHOVOT SERIES varies from 200 to 250 pages.

*

Subscriptions are payable in advance by crossed cheque or postal order and should be forwarded to the ADMINISTRATION of the PALESTINE JOURNAL OF BOTANY, P.O.B. 620, JERUSALEM, PALESTINE. The subscription price is

25 s. per annum, post free, for both series
18 s. per annum, post free, for JERUSALEM SERIES separate
12 s. per annum, post free, for REHOVOT SERIES separate.
(single number 6 s., double number 12 s.).

*

Correspondence concerning editorial matters should be addressed for the JERUSALEM SERIES to PALESTINE JOURNAL OF BOTANY, P.O.B. 620, JERUSALEM, PALESTINE, for the REHOVOT SERIES to PALESTINE JOURNAL OF BOTANY, P.O.B. 15, REHOVOT, PALESTINE.

*

Business correspondence, including notice of change of address, remittances, advertisements, etc. should be addressed to the ADMINISTRATION of the PALESTINE JOURNAL OF BOTANY, P.O.B. 620, JERUSALEM, PALESTINE.

M. Shoham's Press, Tel Aviv, Tel. 2239, P.O.B 576.

CONTENTS OF THE NEXT NUMBER
(to be issued in December, 1938)

PALESTINE

JOURNAL OF BOTANY

Contents of JERUSALEM SERIES Vol. I, No. 1 June 1938

Dedicated to the memory of OTTO WARBURG

THIS SECOND VOLUME OF THE

REHOVOT SERIES

IS DEDICATED TO THE MEMORY OF

OTTO WARBURG

THE RENOWNED BOTANIST

AND ONE OF THE FOUNDERS OF THE

AGRICULTURAL RESEARCH STATION

REHOVOT

OTTO WARBURG

1859 — 1938

laying the foundation stone of the first building of the Agricultural Research Station, Rehovot

PALESTINE
JOURNAL OF BOTANY

Vol II, No. 1 *Rehovot Series* **September 1938**

"Palestine Journal of Botany" appears in two series: the Rehovot Series and the Jerusalem Series.

The Rehovot Series is a continuation of "The Palestine Journal of Botany and Horticultural Science", founded by H. R. Oppenheimer in 1935. It is now edited by H. R. Oppenheimer and I. Reichert of the Agricultural Research Station at Rehovot. This series is an organ for pure as well as for applied botany. Two issues will be published annually.

The Jerusalem Series is edited by the staff of the Department of Botany of the Hebrew University at Jerusalem (Director: A. Eig). This series is chiefly intended to serve an organ for regional botanical researches of the Near East countries. Four issues will be published each year.

A brief summary in Hebrew of each paper appears in the same issue.

Since going to press, botanical science in this country has once again suffered another irreparable loss: the death has occurred of Prof. Alexander Eig, the noted botanist of the Hebrew University. Unfortunately, it is too late to include in this issue an appreciation of Prof. Eig's important scientific work but this will be given in the next number.

OTTO WARBURG

By ISRAEL REICHERT

It is a tragic fate that the first issue of the present edition of this journal which is dedicated to botanical research in Palestine must commemorate the death of Otto WARBURG, the man who did so much for agriculture and botany in this country.

The death of Prof. WARBURG was a great loss to world botany in general and to this young science in Palestine in particular. In the following lines an attempt is made to sketch his life and scientific achievements.

YOUTH AND STUDY (1859—1884)

Little is known of the early life of Otto WARBURG. In his autobiography, which he wrote upon the author's suggestion, after his 70th birthday, he skipped this stage and began with the year in which he graduated from gymnasium. Nevertheless, those internal forces which directed his life and scientific pursuits were undoubtedly formed during this period.

WARBURG was born at Hamburg, in 1859 of exceedingly wealthy parents. He was given a classical humanistic education, free from any trace of Judaism. Jewish tradition was absent from his home and many of his relatives left the faith of Israel. During conversations with WARBURG it was often surprising how foreign all Jewish customs and traditions were to him.

At the "Johannaeum" Gymnasium he was introduced to the finest aspects of classical German culture. His knowledge of German was excellent and his profound understanding of Greek and Latin was later of great service to him in his botanical work and in his naming of innumerable new species of plants, both in Latin and in German.

Hamburg with its beautiful surroundings made a deep impression upon him. He was attracted to nature and the sea which he crossed many times in his travels to distant countries.

When he graduated from gymnasium in 1879, WARBURG entered university, studying at Bonn, Berlin, Hamburg and Strasbourg. It seems that while yet a university student he decided to devote himself to botanical research. He chose botany as his major subject and gave most of his attention and time to it. As minors he selected zoology and chemistry. In his last year he studied under DE BARY, the celebrated botanist and mycologist. WARBURG took his doctor's degree examination with DE BARY. The influence of his teacher is recognizable in WARBURG's botanical works, and was particularly manifested by his interest in lower plants collected during his journeys and also so wonderfully described in his book "Die Pflanzenwelt", written towards the end of his life.

Upon finishing the university he decided to acquire a deeper and more specialized knowledge of botany. He spent half a year, the winter of 1883/84, working at Munich in the laboratory of Adolf von BAYER, the noted chemist of his time and one of the first to win the NOBEL Prize. The following year WARBURG worked under Prof. PFEFFER, the famous physiologist in Tuebingen. Here WARBURG published two papers, one of which (1) appearing in 1886, was on the significance of organic acids in the life processes of plants, particularly succulents. He proved experimentally that malic acid, which accumulates in the leaves of succulent plants during the night, is not an intermediate product of photosynthesis, as LIEBIG and others believed, but rather an intermediate product of respiration. An other paper was on the influence of the lignification of cells on the life processes of the cell contents (7). WARBURG attempted to discover whether lignified cells could again become meristematic. DE BARY, TH. HARTIG and others believed in this possibility while GOEPPERT and SORAUER opposed it. After detailed histological studies of various climbers and other plants WARBURG found that lignified cells remain alive but generally lose their ability to form a secondary meristem, i. e. the process of lignification is, as a rule, irreversible. This is the opinion held today, though some exceptions have been described.

This work, carried out in PFEFFER's institute, might, in the natural course of events, have led WARBURG to become a university lecturer in plant physiology and anatomy but he soon left this field of research. He was more attracted to the various

forms of plants, their associations and distribution. These problems then absorbed the attention of botanists and biologists throughout the world. The research voyages of the two English scientists, Darwin (1832/36) and Wallace (1854/62) completely revolutionized the study of biology. The changes and alterations in the families, genera and species of plants and animals which had been observed during their travels and explorations in far flung countries and islands; the discoveries of plant and animal fossils in the depth of the earth and of their relations to the plants and animals of our day;—all shook the foundations of the old accepted biological theories concerning the stability of plant and animal forms. Both Darwin and Wallace developed theories of the evolution of species, each without knowledge of the findings of the other. No other theory has ever furnished so satisfactory an explanation of all the wonders of the distribution of plants and animals. These theories of evolution quickened the pulse of biological research all over the world to an extraordinary extent. Various research workers travelled to all parts of the globe and began to collect plants and animals which had until then been hidden in unexplored countries. New books on the distribution of organisms in the past and present appeared continually.

While Warburg was still at the university two such books were published which made an indelible impression on the biologists of the time and among them, Warburg. One was the work of Adolf Engler on the history of the development of plants, "Versuch einer Entwicklungsgeschichte der extratropischen Florengebiete", the first volume of which appeared in 1879 and the second in 1882. In this book the author traced the development of plants from the earliest time to the present. He explained the present day existence and distribution of plants on the basis of the study of their distribution and development in the past. This method of research served to clarify many hitherto unexplained phenomena.

The second book which appears to have made a deep impression on Warburg was Wallace's "Island Life" which was published in 1880. In this work Wallace summarized his views on the laws governing the distribution of plant and animal life in various islands and the conclusions which might be drawn from these laws with regard to the evolution of species.

Of all the problems which ENGLER and WALLACE studied, the question of the distribution of the plants of the Malayan Islands was of the greatest interest to WARBURG. On the basis of the geographical distribution of certain animals such as marsupials and parrots WALLACE drew a line dividing the eastern part of the Malayan Islands, including Celebes, the Small Sunda Islands and New Guinea from the western Malayan Islands, Sumatra, Java, Borneo, etc. He associated the western part of the Islands with the Indian animals and the eastern part with the plant world and the marsupials of eastern Australia. This line of demarcation became known as the WALLACE Line.

ENGLER accepted this geographical division in his determination of floristic areas. He also associated the eastern Malayan Islands and New Guinea with Australia in what he referred to as the Australian-Malayan Region. WARBURG took it upon himself to test the soundness of this hypothesis by visiting the regions in question personally and doing research work there.

TRAVELS AND DISCOVERIES (1885—1896)

WARBURG spent half a year making preparations for his daring voyage. He worked in the herbaria of Berlin and Kew, studying the plants and literature of the tropical countries of southern Asia, Australia, and the islands of the Pacific Ocean. There he armed himself with all the weapons necessary for his long journey.

In the fall of 1885 he left Europe for India and Ceylon. There for the first time in his life he came into contact with tropical vegetation in the primeval forests of India. Next he travelled to Java. Here he remained for a whole year working at the famous botanical laboratory which had been founded by the Dutch in Buitenzorg under the direction of Prof. TREUB. According to his autobiographical notes, WARBURG did a great deal of mountain climbing, travelling throughout the country, visiting plantations and working on many taxonomic and phytogeographical problems. In this manner he gained all the information necessary for the continuation of his travels. In order to receive a reliable impression of the various factors influencing the different countries concentrated in this corner of the world he decided to visit Japan and China. He, therefore, left Java in the winter of 1886/87 and passed from Singapore to Bangkok, Shanghai and Pekin. From there he continued through Korea,

Japan, the Liu Kiu and Volcano Islands, Formosa, the Philippines, New Guinea, Kaiser Wilhelms Land and the islands of the Archipelago of Bismarck to eastern Australia.

In each of these places WARBURG visited forest and wilderness ,working from morning to night for years, observing the various forms of life and collecting valuable plants. One can obtain an idea of the size of these collections from the fact that in New Guinea alone, he gathered 753 different plants, most of them from ancient inaccessible forests where the foot of man had never trod. The following passage taken from WARBURG's work on New Guinea (6) describes the hardships involved in his work. He wrote: "The number of forest trees might undoubtedly have been much greater had it not been so difficult to collect them. In order to get a good view of the trees it was necessary to lie on the ground. It was almost impossible to make observations while walking through the woods". For four years WARBURG worked under these conditions and in the summer of 1889 he returned to Germany.

Upon his return to Germany he settled in Berlin and began to organize at the Botanical Museum, the vast quantity of material which he had brought back from his travels. He laboured day and night and it was not long before he recognized the great value of his collections. Of the 753 plants which he brought from New Guinea alone, he found that 153 were new species and six were new genera.

The news of his discoveries spread rapidly and he was invited to lecture before various societies on the impressions of his travels and the results of his research. He delivered a number of lectures in 1889 and 1890 before the German Geographical Society in Berlin and later at the annual general meeting of the German Society of Physicians and Naturalists (2, 3, 4, 5).

In 1891 his first great work on his travels was published in ENGLER's journal "Botanische Jahrbuecher" (6). This paper covered 225 printed pages. Its value lay, not so much in the large number of new plants which he had discovered ,as in the new general phytogeographical observations made on the basis of his findings.

The main innovation that he made, which was almost revolutionary in its time, was the conclusion that WALLACE and ENGLER erred in separating the vegetation of New Guinea

and the east Malayan Islands from the west and connecting it with that of Australia. WARBURG based his conclusions upon the following:

There is a close relationship of the plant world of New Guinea and the east part of the Malayan Islands (Molukes, the Small Sunda Islands and Celebes) to the western part of the Malayan Islands (Sumatra Borneo, Java and Bali). He furnished as proof of this statement the fact that of the 735 species which he found in New Guinea, 527 were common to both the E. and W. Malayan Islands. Most of these were forest trees or other plants which do not tend to spread easily. Only a small number of plants (5 new species and 10 new genera) were found in the east and not in the west. He considered this fact as sufficient basis for the assumption that there was once a land link between New Guinea and the east and west islands of the Malayan Archepelago.

The vegetation of New Guinea differs from that of Australia. This he proved by the evidence that of the 753 plants brought back from New Guinea, only 209 were to be found in Australia. On the other hand 527 of these plants were discovered in the Malayan Islands. The difference is actually even more striking for, as WARBURG proved, almost all the plants common to New Guinea and Australia, instead of belonging to the forest vegetation which spreads with difficulty, were coast, field and cultivated plants which are more easily distributed from place to place. In addition, WARBURG emphasized that not one of the principal Australian savannah forest trees such as the *Eucalyptus* or *Banksia* was found in New Guinea. Also, not a single species of *Myristica,* which are very common in New Guinea, where they comprise more than 30 species was to be found in Australia. This proves clearly that these two countries had not been connected and had no mutual exchange of plants. At any rate, no such linkage of the two countries existed since the time of the formation of their present day principal floras, i. e. the savannah forests in Australia and the *Myristica* vegetation in New Guinea.

After WARBURG had proved that no basis exists for the assumption that there is a close relationship between the vegetation of New Guinea and Australia, he raised the question whether New

Guinea differs in some way from the Malayan Islands so as to necessitate the division of the two into separate phytogeographical regions. Grisebach, in his book "Vegetation der Erde", in 1884, suggested that both should be united into one plant province. Warburg, on the basis of his examination of the plants found in New Guinea. arrived at the conclusion that these plants belong to a special region by themselves. The reasons given for this separation were: first, the great number of endemic plants found in New Guinea (of the 753 plants found there. 206 or 27% were endemic species, that is, they were absent from all the other neighbouring islands) and second, 15 genera of the New Guinea plants were absolutely unrelated to any of the genera appearing in the Malayan Islands. Plants related to these 15 genera were to be found in Africa and America. On the strength of this evidence, Warburg decided that New Guinea and its surrounding islands, the Kiu and Aru Islands, could be treated as a unit. He named this unit *Papuasia* after the Papu tribes which lived there. This name has since been accepted by science.

This work of Warburg was a most valuable contribution to the study of the geography of plants, particularly in the southern Hemisphere. It attracted the attention of a number of botanists, among them Gibbs, Ledermann and Schlechter to this region and led them to visit it themselves and make rich collections which helped to complete the picture Warburg had drawn.

In addition to his work on Papuasia Warburg, during the same period, published papers on his research on Liu Kiu Island, Bonin, the Volcano Islands, Formosa and others (2, 3, 4).

Height of scientific activities (1894—1900)

Warburg reached the height of his creative powers from 1896 to 1900. In 1897 he published two works which earned him renown in the world of scientific literature and made his reputation in the circles interested in tropical agriculture. Both works were about the *Myristicaceae*. As previously mentioned, the many varieties of *Myristica* which he found in New Guinea aroused his attention. These plants were very important in the export of these tropical countries.

In his book "Die Muskatnuss" (10) (628 pages) he described in detail and with great skill the nature and distribution of this

Myristica, the conditions necessary for its growth and the history of its exploitation by the first conquerers of the colonies.

The second book dealt with all the species of *Myristica* found in the tropical parts of Asia, Africa and America and was based upon the material which he had brought back from his journeys in south-east Asia and that collected by botanists in other parts of the world (9). In this investigation WARBURG made a number of very important discoveries. Until that time there were only three known genera in the *Myristicaccae* family. One of these was *Myristica* which had been classified by LINNÉ in 1742. WARBURG, however, discovered in his material, eleven new genera comprising 100 new species. He described all these new plants in the greatest detail. This monograph was monumental, containing 680 square pages of quart size with 25 plates of illustrations. It was published by the Leopoldina-Carolina Academy in Halle (Germany). During the same period WARBURG was engaged for a number of years in the compilation of another enormous work which was not published until 1900. This was the first volume of a set of books which he intended to put out under the title "Monsunia" (14). The object of this set was to give a critical review of all the plants in the tropical monsoon region, i. e. the Malayan Islands and surrounding countries, in the manner of the work of HOOKER on British India. For this purpose WARBURG examined all the collections ever made by botanists and tourists in this region.

WARBURG was awarded the De Candolle prize for these two works. He became known as one of the greatest phytogeographists and experts on tropical plants. ENGLER invited him to prepare monographs of the tropical plants to be described in his works "Die natuerlichen Pflanzenfamilien" and "Das Pflanzenreich". WARBURG accepted this invitation and prepared monographs on the following families: Buxaceae, Winterananae, Sabiaceae, Balsaminaceae, Flacourtiaceae, Begoniaceae, Datiscaceae, Pandanaceae and Myristicaceae.

WARBURG was invited to lecture on the geographical distribution of plants before the international Geographical Congress which took place in 1899 at Berlin (13).

At about this time his purely scientific research was interrupted by changes in German policy. A national movement sprang up in Germany for the purpose of acquiring colonies in tropical

countries to furnish raw materials to German industry. Warburg, because of his widespread experience in connection with tropical agriculture was requested to act as an adviser in this movement. In 1896 the "Kolonial-Wirtschaftliche Kommittee" was formed to further the development of the colonial movement by stimulating trade spreading information regarding tropical countries etc. Warburg was one of the founders of the committee and also one of its most active members. He and Prof. Wohltmann were made editors of a special journal called "Der Tropenpflanzer" which was devoted to tropical agriculture. In truth, however, Warburg alone, edited this paper for 25 years, bringing it up to a high standard. In this journal he printed many of his own articles as well as those of experts all over the world. Thus this journal became a world centre for scientific study on the agriculture of tropical countries (11).

In addition to this monthly journal he published a supplement under the name "Beitraege". This was a publication of books in the form of monographs on agriculture in various countries. Among them he published, in 1898, a book on rubber raising throughout the world. This was also translated into French (12).

In this period, as previously mentioned, Warburg attained his greatest fame. He was awarded an honorary professorship and given an appointment as a lecturer on tropical agriculture at the University of Berlin.

Colonies and colonization (1901—1911)

Whereas in the period from 1896 to 1900 Warburg reached his highest attainments in scientific research, in the years which followed, 1901 to 1911, he entered a new stage of practical achievement. He discontinued his purely scientific research and his study of the flora of the Malayan Archepelago to which he had devoted the first volume of the "Monsunia". This work was cut off without the sequel which Warburg had planned, and it was the last of his great works on plant systematics and phytogeography. Instead, he devoted himself completely to practical problems of agriculture in the various German colonies. All his thoughts at the time were directed to the one idea, how to develop the colonies and enrich them with new economic plants. He founded societies of planters of coffee, bananas, oil producing crops, etc., in the various German colonies, at Usumbara, Cameroon, and the Samoan Islands.

The author believes that one of the reasons why WARBURG left the field of pure botanical research was because he saw his being a Jew would prevent his ever attaining the position he deserved at a university, and his appointment as a regular ("ordentlich") professor of botany. On the other hand, there can be no doubt that he also had the inclination for colonial activity, for he found in it a union of scientific theory and practice.

At this time he made a trip to Turkey in order to study cotton raising. In Turkey he came across small agricultural settlements of Roumanian Jews who suffered greatly from misfortunes in wandering and the hardships of settlement. He was touched by their fate and rendered them much assistance by his advice and money. These settlements failed at length and were deserted. This experience led him to take a whole hearted interest in Palestine, which had been chosen by the new Zionist Organization under its founder Dr. THEODOR HERZL of Vienna, as the land for the settlement of the Jews. He had heard about Palestine before this from his father-in-law, GUSTAV COHN, long a lover of Zion. Through his father-in-law WARBURG came into contact with HERZL, the Zionist Movement, and Palestine. He was interested in Zionism as a means to settle Jews as agriculturists in Palestine. For this reason he willingly accepted HERZL's invitation, in 1904, to join the committee for the development of Palestine. He devoted himself to it with all his heart and wealth of information. He championed colonization and the extention of established settlements in Palestine at a time when official Zionism was concerned only with diplomatic negotiations. It was because of him that various land purchasing and planting companies (HERZL Forest, Palestine Land Development Comp. etc.), were founded. Today it may be stated that it was WARBURG who helped to introduce rational, practical agriculture as an integral part of the Zionist Movement.

He greatly assisted the new settlement movement by forming the Palestine Committee under the head of Dr. RUPPIN and Dr. THON. Together with Dr. OPPENHEIMER and Dr. SOSKIN, WARBURG established the monthly journal "Altneuland" in which he printed many articles on Palestine agriculture and economic plants (15). He also gave full support to the pioneer agricultural research work of the late A. AARONSOHN, the famous agronomist, in his agricultural exper-

iment station at Athlit. The vast experience which he had gained in the German colonization work was invaluable in his Palestinian activities.

In service of his people (1912—1919)

National movements are known to draw men away from their chosen fields. Warburg who came from a foreign world in which he had been completely involved in other matters taking up all his time was captured by the Zionist Movement. His splendid character, especially his sense of fairness, modesty, generosity, open heartedness, gentleness, common sense, and understanding of problems dealing with colonization and agriculture paved his way to the presidency of the Zionist Organization. He was elected to this office in 1911 at the Zionist Congress in Hamburg and retained his post until 1919. He directed the Zionist Organization peacefully and with dignity through the perils of the World War.

He carried the emblem of Palestine and Zionism proudly. In 1917, the German minister of Foreign Affairs published a declaration in support of Zionism promising, in the event of German victory, the opening of the gates of Palestine to the Jews for development and settlement there. Prof. Alfred Philippson, a well-known expert on Mediterranean countries and a Jewish assimilationist who sharply opposed Zionism set out to prove in the "Berliner Tageblatt" the unsuitability of Palestine for colonization using as his weapon his extensive geographical knowledge. Warburg answered him proudly and daringly in defense of Zionism and Palestine.

Warburg gave most of his time to his Zionist activities. Yet in addition to the edition of the monthly "Der Tropenpflanzer" he managed to publish in 1913 the first volume of his book "Die Pflanzenwelt" (16) which will be discussed later. In the meantime, he prepared the rest of his material but did not find the time to complete it. The war and his personal worries as well as his important national responsibility prevented him from continuing the serious scientific work he had done in the past.

Rise and Fall (1920—1938)

After the end of the World War, at the close of 1919, a new Executive Committee and a new president were elected by the Zionist Organization. Warburg was thus relieved of his office and responsibility. Although the war clouds had dispersed, Warburg's economic

position became less secure because of his great financial losses from investment in the colonies taken from Germany. He was left without the spiritual peace necessary for his work.

He made one last great effort to complete the work he had begun during the war. He finished the book "Die Pflanzenwelt" and published it in two parts, one in 1921 and the other in 1922. This was the last of his books to bring him great fame. WARBURG was the first botanist to succeed in presenting, in this work, a sketch of the plant kingdom containing a summary of the latest systematical, geographical, and economic knowledge. Few botanical research workers in the world had ever before been able to combine within themselves such diversified information on economic and geographical botany on the basis of their experience and investigations. This book remains unparalleled in the world's botanical literature. His literary style was attractive without lessening the high scientific standard of the book. The abundance of beautiful illustrations presented were drawn according to the directions of the author and represented nine years of labour. "Die Pflanzenwelt" was unanimously welcomed into the literature on the subject and brought great honour to its author.

An important contribution in this book was the germanizing of the Latin names many of which until then had no German equivalents. This enormous and important piece of work was appreciated and recognized by German botanists and school teachers.

But this was WARBURG's last scientific success, although in 1922 he published another large book "Kulturpflanzen der Weltwirtschaft" (17). Like "Die Pflanzenwelt" this book had been prepared, for the most part, during the war. In the same year (1922) he resigned from his position as editor of "Der Tropenpflanzer" which he had held for 25 years (1887—1922) and through which he had gained world wide recognition.

Thus WARBURG suddenly found himself isolated and lonely. The changes in Zionist policy brought about by the Balfour Declaration excluded the German Jews from further political influence, himself included, upon the development of affairs in Palestine under the British mandate. He had abandoned his scientific research for his Zionist activities and now found himself left without either. This at first caused him great suffering. He was however rescued from this position by an unexpected proposal. The meeting of the Zionist

Executive Committee at London in 1919 appointed I. VOLCANI, the well known Palestine agronomist, to found an agricultural research station in Palestine. VOLCANI invited WARBURG, as the world famous agriculturalist-botanist, to co-operate with him in the organization of the institution. With great joy, WARBURG accepted the invitation for it offered him the opportunity to fulfil his long sought after desire to synthesize theoretical and applied agriculture, especially in Palestine. He came to Palestine in 1922 and remained for a few months.

Besides helping in the general direction of the Agricultural Research Station, which was naturally limited to a certain extent, WARBURG was occupied in the development of its Division of Botany. In the course of time he found an able and loyal assistant in Dr. A. EIG who later succeeded him as head of the Department of Botany of the Hebrew University, Jerusalem.

It is certain that if WARBURG had been able to settle permanently in Palestine (the illness of his wife prevented him from doing so) he woull have been able to take successfully an active part in the new trend of practical agriculture and would undoubtedly have renewed his scientific research. He often spoke of such plans to be carried out when he would succeed in taking up his permanent abode in Palestine. Never, however, was he able to settle permanently in this country for he was obliged constantly to wander back and forth. First when the Agricultural Research Station was in Tel Aviv, between Tel Aviv and Berlin, and later when the Agricultural Research Station was transferred to Rehovot and the Botanical Division to Jerusalem, between Berlin, Rehovot and Jerusalem. In this manner his great energy was dissipated and he was unable to do any further great research.

Together with Dr. EIG, he published a number of papers on the taxonomy of Palestinian plants (18, 19). His last work, which was done in Palestine, was a study of the white lily (20). Here he traced the distribution of the White Lily from the place of origin of its relatives in eastern and southern Asia to its present day Mediterranean habitat, including Palestine, where it was newly discovered. This plant is a relic of the period in which hygrophilous plants such as Cedrus, were widespread. In this paper are found all the excellent features which distinguished WARBURG's scientific research: extraordinary exactness, untiring collection of details and

wealth of information concerning not only botany but also history, arts and philology. This was WARBURG's swan song. He wished to write a history of botanical exploration in Palestine and took many notes on the subject but it is uncertain whether he ever completed this work.

In the course of time, as already mentioned, WARBURG transferred the Division of Botany from the Agricultural Research Station to the Hebrew University in Jerusalem. He was exceedingly happy that his work would be realized on the heights of Mt. Scopus.

The lack of stability in the life of WARBURG and the new situation of the Jews in Germany broke his spirit and weakened his health. The death of his wife was the greatest blow of all to him. He hoped to recover from this tragedy and return to Palestine and in a letter, dated May 25th, 1937, he wrote, "You knew my wife and can understand how great is my loss. This has been the first year since the war in which I did not visit Palestine. I hope to be able to come next year for a few months, if the inevitable does not occur. In the meantime the pain in my legs prevents me from making definite plans for the future". The pain in his legs turned out to be a serious affliction which led to paralysis of the spine and eventually brought about his death on January 10, 1938. Thus was extinguished the light which had burned so long and brightly for science and Israel.

SELECTED PUBLICATIONS OF WARBURG MENTIONED IN THIS ARTICLE

1. WARBURG, O. (1886). Ueber die Bedeutung der organischen Saeuren fuer den Lebensprozess der Pflanzen, besonders der Fettpflanzen. *Untersuchungen aus dem Bot. Institut zu Tuebingen,* 2:53—150.
2. WARBURG, O. (1889). Meine Reise nach Formosa. *Verhandl. der Ges. f. Erdkunde zu Berlin* 16, 14 pp.
3. WARBURG, O. (1891). Eine Reise nach den Bonin- u. Volcano-Inseln. *Verhandl. der Ges. f. Erdkunde zu Berlin* 18:248—268.
4. WARBURG, O. (1890). Die Liukiuinseln. *Mitt. d. Geograph. Ges. in Hamburg,* 24 pp.
5. WARBURG, O. (1890). Die Flora des asiatischen Monsungebietes. *Verh. d. Ges. d. Naturforscher u. Aerzte,* Allg. Teil 8:19 pp.
6. WARBURG, O. (1891). Beitraege zur Kenntnis der papuasischen Flora. *Englers Bot. Jahrb.* 13:230—455.
7. WARBURG, O. (1893). Ueber den Einfluss der Verholzung auf die Lebensvorgaenge des Zellinhaltes.*Ber. Deutsch. Bot. Ges.* II:425—441.
8. WARBURG, O. (1893). Vegetationsschilderungen aus Suedwest-Asien. *Englers Bot. Jahrbuecher* 17:169—176.
9. WARBURG, O. (1897). Monographie der Myristicaceen. *Nova Acta der Kaiserl. Leop.-Carol. Deutsch. Ak. der Naturforscher,* 68:680 pp., 25 plates.
10. WARBURG, O. (1897). Die Muskatnuss, ihre Geschichte, Botanik, Kultur, Handel u. Verwertung etc. Leipzig, 628 pp.
11. WARBURG, O. (1897—1922). Der Tropenpflanzer. 25 vols.. Berlin.
12. WARBURG, O. (1900). Die Kautschukpflanzen u. ihre Kultur. 154 pp., Berlin.
13. WARBURG, O. (1901). Einfuehrung einer gleichmaessigen Nomenclatur in der Pflanzengeographie. *Englers Bot. Jahrb.* 29, Beibl.. 66:23—29.
14. WARBURG, O. (1901). Monsunia. Volume I, 207 pp. 11 plates. Leipzig.
15. WARBURG, O. (1904—1906). "Altneuland", Zeitschrift f. wirtschaftliche Erschliessungen Palaestinas. Vol. I—III.
16. WARBURG, O. (1913—1922). Die Pflanzenwelt. Leipzig, 3 Vols., 31 coloured plates, 62 uncoloured plates, 768 figs., 1715 pp.
17. WARBURG, O. and van SOMMEREN-BRAND, J. E. (1922). Kulturpflanzen der Weltwirtschaft. 411 pp., 653 pls., 12 coloured plates, R. Voigtlaender. Leipzig.
18. WARBURG, O. and EIG, A. (1926). Pisum fulvum Sibth. et Smith n. var. amphicarpum. *Agric. Records* (published by the PZE Institute of Agric.) 1.
19. WARBURG, O. and EIG, A. (1928). Zwei neue Leguminosen aus der Ebene Esdraëlon in Palaestina. *Feddes Repert. spec. nov. etc.* 25:350—352.
20. WARBURG, O. (1929). Heimat and Geschichte der Lilie (Lilium candidum). *Feddes Repert. spec. nov. regn. veg.* Beih. 56:167—204.

III. UNE CONTRIBUTION A LA CONNAISSANCE DE LA FLORE DU BOSPHORE *)

PAR M. EVENARI ET H. R. OPPENHEIMER

Fidèle à l'esprit de feu Aaron Aaronsohn pour qui le réputé Professeur WARBURG *fut un excellent maître et ami, la famille Aaronsohn désireuse de s'associer à la pieuse commémoration érigée dans ce bulletin a bien voulu mettre à notre disposition ce manuscrit jusqu'ici inédit.*

En Mai 1908, Aaron AARONSOHN arrivait à Istanbul au palais du Sultan Abdul Hamid II. Il était accompagné du Professeur BLANCKENHORN, géologue, avec lequel il venait d'explorer le bassin de la Mer Morte. Les deux savants rapportaient le riche butin recueilli au cours des deux mois précédents, et il s'agissait maintenant, en collaboration avec I. AHARONI, qui lui avait été chargé de la partie zoologique de la Mission, d'organiser pour le Sultan un Musée d'Histoire Naturelle.

Or, si AARON AARONSOHN participa à cette expédition d'une si haute portée scientifique, ce fut grâce à l'intervention du Professeur WARBURG et l'on comprend que celui-ci lui en ait gardé jusqu'à la fin de sa vie trop brève une reconnaissance émue.

---

*) La première partie des "Reliquiae Aaronsohnianae" parut en 1931 sous le titre "Florula Transjordanica" (rédigé par Oppenheimer) dans le Bulletin de la Société Botanique de Genève. Une édition en hebreu parut en 1934.

Une deuxième publication rédigée par les auteurs du présent article est sous presse. Elle va paraître tout prochainement dans un volume spécial de ce même bulletin.

Pendant son séjour au Palais Yildiz (Mai—Juillet 1908) Aaron Aaronsohn utilisa ses loisirs à herboriser dans les environs d'Istanbul. Il prit contact avec cette riche flore de la région du Bosphore, si intéressante au point de vue phytogéographique. Au point de rencontre de l'Europe et de l'Asie Mineure nous nous trouvons en effet en présence d'un très curieux mélange d'éléments balkaniques, méditerranéens, sarmatiques et proche-orientaux que personne à notre connaissance n'a encore distingué d'une façon systématique.

Les botanistes pourtant n'ont point manqué dans la région du Bosphore pendant le siècle dernier. Il suffit de mentionner: Aucher-Eloy, W. Barbey, Clementi, Dingler, Grisebach, Janka, Noe, G. Post, Sibthorp, etc. Mais c'est au commerçant arménien G. Aznavour que revient le mérite d'avoir, avec le plus de soin, étudié au début de ce siècle les plantes de cette région (peut-être accompagna-t-il Aaron Aaronsohn dans ses excursions autour d'Istanbul; en tous cas les deux botanistes échangèrent des "Exsiccata"). Aznavour constitua un riche herbier, actuellement entre les mains du Dr. Bertram V. D. Post du "Robert College" americain. C'est le Dr. Post également qui depuis des années travaille sur l'"Aide-Mémoire" manuscrit qu' Aznavour avait consacré à la flore du Bosphore. Les résultats des premières études du botaniste arménien ont paru dans le *"Bulletin de la Société Botanique de France"* (1899 etc.). Mais, sous l'influence, semble-t-il, du botaniste hongrois v. Degen, ce sont les *"Magyar Botanikai Lapok"* qui publièrent les autres résultats.

Citons encore le prêtre autrichien Wimmer qui de nos jours a herborisé dans la même région et dont les collections se trouvent au Musée National d'Histoire Naturelle à Vienne. Les collections de Niemetz doivent être l'object d'un ouvrage que publiera le Dr. K. H. Rechinger fils.

Nous espérons la parution prochaine d'une flore illustrée du Bosphore par Post. C'est pourquoi il nous semble important de faire connaître les stations supplémentaires établies par feu le naturaliste palestinien Aaron Aaronsohn.

Nous savons peu de chose sur les excursions d'Aaron Aaronsohn aux alentours de la ville. Les notes de son journal manquent à ce sujet. Reportons-nous à ce qu'écrivit Blanckenhorn: "Ainsi, il nous restait, surtout en Juin, lorsque nous attendions encore, avant

toute autre chose, l'arrivée des armoires, beaucoup de temps, que nous nous empressions d'utiliser, particulièrement les dimanches et les vendredis, à faire des excursions dans les ravissants environs d' Istanbul, sur les bords de la mer de Marmara avec ses Iles des Princes et le long du Bosphore." (Naturwiss. Studien am Toten Meer und im Jordantale — Berlin 1912).

Les plantes recueillies par AARONSOHN proviennent des deux rives du Bosphore. Sur le rivage européen il a surtout herborisé dans la région de Belgrade "hantée par les loups" (au Nord d'Istanbul), à la Corne d'Or, dans le bois d'Eyoub, à Masslak (à l'Ouest du Bosphore) et à Djirdjir (espèces hygrophiles).

Ses excursions sur la côte de la mer de Marmara le conduisirent à Yeshilkeuy (San Stefano), et à Yédikoulé située à l'extrémité de la vieille enceinte de la ville.

Sur la rive asiatique, il a visité Tchenghelkeuy et la colline Tchamlidja que caractérise une extraordinaire aridité et une végétation steppique de lavandes.

Messieurs les docteurs K. H. RECHINGER fils, de Vienne, et Bertram V. D. POST d'Istanbul nous ont très obligeamment aidés dans la détermination des plantes douteuses. Le Professeur L. BRAUNER d'Istanbul nous a fourni d'importants renseignements sur les localités visitées par AARONSOHN. Le Dr. K. AULICH d'Istanbul nous a exécuté les photographies.

Nous les remercions ici très cordialement des services qu'ils ont bien voulu nous rendre.

DATES ET LOCALITÉS DES HERBORISATIONS d'AARONSOHN DANS LA REGION DU BOSPHORE.

15.V.1908 — Haskeuy.
16.V.1908 — Tchenghelkeuy.
17.V.1908 — Bois d'Eyoub.
22.V.1908 — Tchamlidja.
23.V.1908 — Sariyer (Masor Bouroun), Djirdjir, Buyukdéré.
4.VI.1908 — Masslak, Kanli Kavak, Baltaliman, Rouméli Hissar.
5.VI. 1908 — Kiat Hané, Férikeuy.
14.VI. 1908 — Yédi Koulé.
21.VI. 1908 — San Stefano (Yeshilkeuy).
24.VI. 1908 — Djirdjir.
5.VII. 1908 — Forêt de Belgrade.

ENUMERATION DES ESPECES

Remarque: Comme dans les autres publications des "Reliquiae Aaronsohnianae", les numéros précédant les noms des localités sont ceux des étiquettes de l'Herbier Aaronsohn. Les numéros pourvus d'un astérique ont été bien determinés par ce savant. Les citations suivant les noms de plantes représentent les tomes et pages du "Prodromus florae paeninsulae balcanicae" d'A. Hayek.

FILICES

Polystichum lobatum (Huds.) Presl — I, 28.—
32) Forêt de Belgrade, 5.VII.1908 (sporangifère).
Nouveau pour le Bosphore.

EQUISETACEAE

Equisetum Telmateia Ehrh. — I, 9.—
Djirdjir, 24.VI.1908 (pousses stériles).

GRAMINEAE

Chrysopogon Gryllus (L.) Trin. — III, 367.—
*399) Masslak ,4.VI.1908.

Trisetum flavescens (L.) Beauv. — III, 311.—
(forma micrantha)
711) Kanli Kavak, 4.VI.1908 (fleurs).

Gaudinia fragilis (L.) Beauv. — III, 322.—
448) Masslak, 4.VI.1908

Briza elatior S. et S. — III, 252.—
340 B) Forêt de Belgrade, 5.VII.1908 (fleurs). — 332) Masslak, 4.VI.1908 (fleurs).—

Cynosurus cristatus L. — III, 255.—
409) Masslak, 4.VI.1908.

Cynosurus echinatus L. — III, 256.—
408) Masslak, 4.VI.1908.

Dactylis glomerata L. — III, 254.—
420) Bois Eyoub, 17.V.1908 (fleurs).

Festuca drymea M. et K. — III, 289.—
443) Djirdjir, 24.VI.1908 (fleurs).

Bromus sterilis L. — III, 210.—
351 A) Bois Eyoub, 17.V.1908. Det. A. de Cugnac-Paris.

Bromus madritensis L. — III. 209.—
351 D) Bois Eyoub, 17.V.1908. Det. A. de Cugnac.

Bromus madritensis L. x? (hybride).—
351 B) Bois Eyoub, 17.V.1908. Det. A. de Cugnac.

Bromus Gussonei Parl. — III, 209.—
351) Bois Eyoub, 17.V.1908. Det. A. de Cugnac.

Bromus mollis L. — III, 212.—
345) Masslak, 4.VI.1908 (fruits).

Brachypodium pinnatum (L.) Beauv. — III, 216.—
322) Djirdjir, 24.VI.1908, (fruits).

Elytrigia (=Agropyron) *repens* (L.) Desv. — III, 219. –
216) San Stefano (Yeshilkeuy), 21.VI.1908 (fleurs).
229) Yédi Koulé, 14.VI.1908.

Elytrigia rigida (Schrad.) Nevski — III, 222.—
217) San Stefano (Yeshilkeuy), 21.VI.1908 (fleurs). Det. S. Nevski. Nouveau pour le Bosphore.

Haynaldia villosa Schur. — III, 230.—
227) Tchenghelkeuy, 16.V.1908 (fleurs).

Aegilops ovata L. — III, 224.—
var. *vulgaris* Eig
190) Tchamlidja, 22.V.1908 (fruits).

Aegilops uniaristata Vis. — III, 226.—
164) Masslak, 4.VI.1908 (jeunes fruits).

Aegilops triuncialis L. — III, 225.—
167) Kanli Kavak, 4.VI.1908 (fleurs).

Lolium perenne L. — III, 298.—
517) Masslak, 4.VI.1908 (fleurs).

Triticum monococcum L. — III. 228.—
San Stefano (Yeshilkeuy), 21.VII.1908 (cultivé). Chaumes à épis longs, glabres (cf. Fig. 1, p. 23) Bornmueller a récolté des matériaux ressemblant à ceux d'Aaronsohn en Anatolie orientale ("Ladek 15.VII.1890, ca. 1000 m. alt. Colitur") Aznavour [Bull. Soc. Bot. Fr. 46, (1899) p. 135] mentionne que ce blé est cultivé dans la région d'Istanbul.

CYPERACEAE

Carex divulsa Good. — III, 165.—
841) Bois Eyoub, 17.V.1908 (fruits). *Forma bracteis inferioribus foliosis.*
443 a) Djirdjir, 24.VI.1908 (fruits). *Forma utriculis apice nigrescentibus.*

LILIACEAE

Smilax excelsa L. — III, 99.—
*1242) Kiat Hané, 5.VI.1908 (jeunes fleurs).

Ornithogalum narbonense L. — III, 81.—
1167) Djirdjir (Buyukdéré), 23.V.1908 (fleurs).

ORCHIDACEAE

Limodorum abortivum Sw. — III,413.—
1458) Djirdjir, 24.VI.1908.

FAGACEAE

Castanea sativa Mill. — I, 71.—
1545 e) Forêt de Belgrade, 5.VII.1908 (fleurs).

Quercus pedunculiflora C. Koch — I. 77.—
1547 e) Djirdjir, 24.VI.1908 (jeunes fruits), Det. B. V. D. Post.

POLYGONACEAE

Rumex Acetosella L. — I, 107.—
1665) Kanli Kavak, 4.VI.1908 (fleurs et fruits).
1663) Kiat Hané, 5.VI.1908 (fleurs et fruits).

CARYOPHYLLACEAE

Dianthus Armeria L. — I, 224.—
2095 a) Forêt de Belgrade, 5.VII.1908 (fleurs).

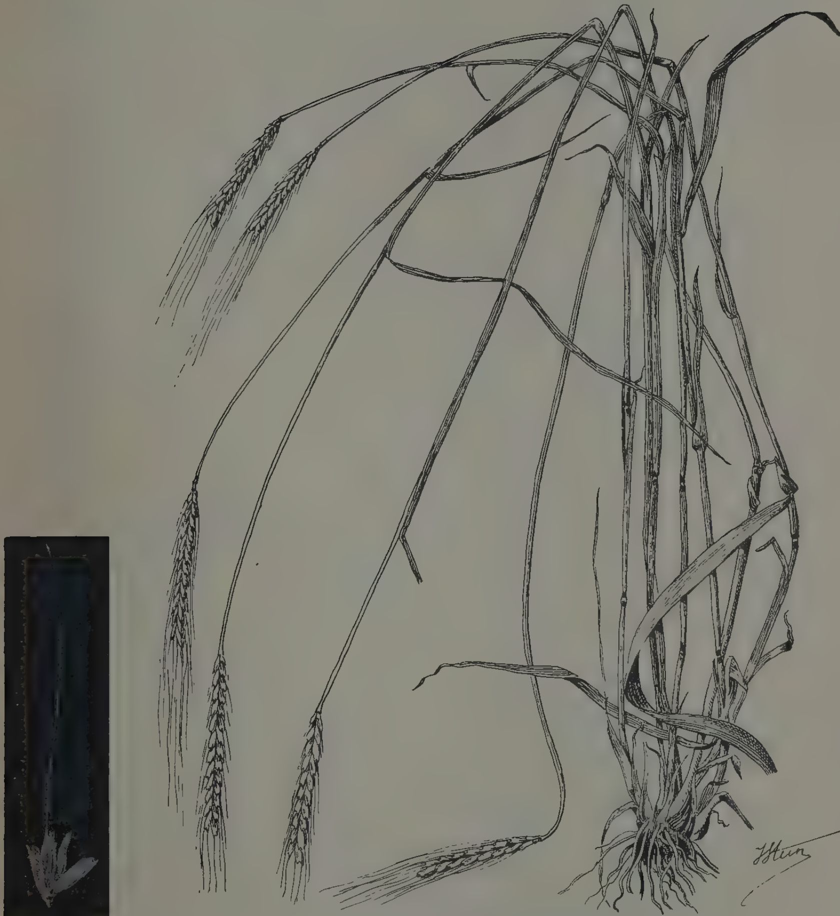


Fig. 1. Triticum monococcum L. récolté par A. Aaronsohn dans champs d'avoine de la région d'Istanbul. — A gauche, épillet isolé.

Dianthus tenuiflorus Gris. — I, 225.—
*2047) Tchamlidja, 22.V.1908 (fleurs).

Dianthus pallens Sibth. — I, 250.—
2084) Forêt de Belgrade, Buyukdéré, 5.VII.1908, stations sèches et ensoleillées, (jeunes fruits).

RANUNCULACEAE

Ranunculus neapolitanus Ten. — I, 342.—
2559) Tchenghelkeuy, 15.V.1908 (fleurs).
2588) Djirdjir, 24.VI.1908 (fleurs).

Ranunculus constantinopolitanus Urv. — I, 342.—
2554) Masslak, 4.VI.1908 (fruits).

Ranunculus sardous Crtz. — I, 344. —
2567) Tchamlidja, 22.V.1908.

Ranunculus arvensis L. — I, 344.—
var. *typicus* Neilr.
2634) Bois Eyoub, sous haie, 16.V.1908.
2615) Yedi Koulé, 14.VI.1908 (fruits).

Ranunculus muricatus L. — I, 344.—
2560) Haskeuy, 15.V.1908 (fruits).

Nigella damascena L. — I, 305.—
2540) San Stefano (Yeshilkeuy), 21.VI.1908 (fruits).

BERBERIDACEAE

Berberis ? vulgaris L. — I, 295.—
2641) Masslak, 4.VI.1908 (pousses stériles).

CRUCIFERAE

Diplotaxis tenuifolia (Jusl.) D. C. — I, 450.—
var. *integrifolia* Koch.
3081) Rouméli Hissar, 4.VI.1908 (fleurs et fruits).

Clypeola echinata DC. — BOISSIER fl. or. I, 309.—
3021) Kanli Kavak, 4.VI.1908 (fruits).

Lepidium spinosum L. — I, 466.—
3238) Kanli Kavak, 4.VI.1908 (jeunes fruits).

Bunias Erucago L. — I, 413.—
var. *macroptera* (Rchb.) Vis.
2979) Bois Eyoub, 16.V.1908 (fleurs et fruits).

CRASSULACEAE

Sedum hispanicum L. — I, 629.—
*3601) Kanli Kavak, 4.VI.1908, Teste H. FROEDERSTROEM-Stockholm.

Sedum tenuifolium Strobl. — I, 628.—
3616) Kiat Hané à Férikeuy ,5.VI.1908.

ROSACEAE

Rubus ulmifolius Schott. — I, 662.—
*3841) Kiat Hané, 5.VI.1908.

Rubus armeniacus Focke.
3838) Djirdjir, 24.VI.1908 (fleurs et j. fruits). Det. Sabransky.

Potentilla reptans L. — I, 688.—
*3760) Masslak, 4.VI.1908 (fleurs).

Geum urbanum L. — I, 696.—
3739) Forêt de Belgrade, 5.VII.1908.

Agrimonia Eupatoria L. — I, 698.—
3730) Djirdjir, 24.VI.1908 (fruits).

Sanguisorba minor Scop. (= *Poterium Sanguisorba* L.)
I, 699
*3786) Tchenghelkeuy 15.V.1908 (fleurs).

Rosa turcica Rouy — I, 731.—
3804) Masslak, 4.VI. 1908.

Pyracantha coccinea Röm. — I, 753.—
3694) Masslak ,4.VI.1908.

Crataegus monogyna Jacq. — I, 755.—
3681) Masslak, 4.VI.1908 (fruits).

LEGUMINOSAE

Lupinus albus L. — I, 893.—
(*sensu latiore* incl. L. *Termis* Forsk.)
4369) Djirdjir, 24.VI.1908 (fleurs).

Genista tinctoria L. — I, 913.—
4131) Forêt de Belgrade, 5.VII.1908 (fruits). — 4797) Tchamlidja, 22.V.1908 (fleurs).

4160) Masslak, 4.VI.1908 (fleurs).

Genista carinalis Gris. — I, 915.—
*4159) Masslak, 4.VI.1908 (fleurs).

Cytisus hirtellus Rchb. (=C. *pygmaeus* Willd.) — I, 902.—
4130) Tchamlidja, 22.V.1908.

Trigonella Foenum graecum L. — I, 832.-
4878) Yedi Koulé, 14.VI.1908 (jeunes fruits).

Melilotus alba Lam. — I, 845.—
4425) Entre Kiat Hané et Férikeuy, 5.VI.1908.

Trifolium hybridum L. — I, 853.—
5104) Sariyer, 23.V.1908. — 4974) Bois de Djirdjir, 24.VI.1908 (fleurs).

Trifolium uniflorum L. — I, 858.—
? var. *Buxbaumii* (Stbg.) Vierhapper.
4912) Tchamlidja, 22.V.1908.

Trifolium striatum L. — I, 859.—
5160) Masslak, 4.VI.1908 (fleurs et j. fruits).

Trifolium arvense L. — I, 864.—
var. *longisetum* Boiss.
4991) Djirdjir, 24.VI.1908 (fleurs).

Trifolium echinatum M. B. — I, 863.—
(= *Tr. supinum* Savi).
4996) Yédi Koulé, 14.VI.1908 (fleurs et fruits). Probablement nouveau pour le Bosphore.

Trifolium stellatum L. — I, 865.—
4961) Djirdjir, 23.V.1908.

Trifolium pratense L. — I, 868.—
5076) Kanli Kavak, 4.VI.1908 (fleurs).

Trifolium ochroleucum Huds. — I, 870.—
var. *roseum* (Presl.) Guss.
4979) Bois de Djirdjir, 24.VI.1908 (fleurs).

Trifolium Cherleri Jusl. — I, 871.—
4991 A) Bois de Djirdjir 24.VI.1908 (fruits).

Trifolium radiosum Wahlbg. (= *Tr. nidificum* Gries.) — I, 874.—
5001) Tchamlidja, 22.V.1908 (fruits).

Trifolium globosum L. — I, 874.—
5017) Tchenghelkeuy, 15.V.1908 (fleurs et j. fruits).

Lotus ornithopoides L. — I, 877.—
4306) Tchenghelkeuy, 15.V.1908.

Dorcynium graecum (L.) Ser. — I, 876.—
(= *D. latifolium* Willd.).
4144) Djirdjir, 24.VI.1908 (fruits).
4150) Forêt de Belgrade, 5.VII.1908 (fruits) .

Dorycnium herbaceum Will. — I, 876.—
4301 A) Djirdjir, 24.VI.1908 (fleurs).
5246) Tchenghelkeuy, 15.V.1908 (fleurs et fruits).

Psoralea butuminosa L. — I, 795.—
4835) Djirdjir, 24.VI.1908 (fleurs).

Ornithopus compressus L. — I,917.—
4794) Bois de Djirdjir, 23.V.1908 (fruits).

Coronilla cretica L. — I, 920.—
*4098) Tchenghelkeuy, 15.V.1908 (fleurs et j. fruits).

Onobrychis aequidentata (S. et S.) Urv. — I, 931.—
*4704) Tchenghelkeuy, 15.V.1908 (fleurs et j. fruits).

Vicia sativa L. — I, 800.—
5246) Tchenghelkeuy, 15.V.1908 (fleurs et fruits).
5264) Yedi Koulé, 14.VI.1908 (fruits).

Vicia hybrida L. — I, 801.—
5245) Tchenghelkeuy, 14.VI.1908 (fleurs et fruits).

Vicia cassubica L. — I, 809.—
5266) Djirdjir, 24.VI.1908 (fruits).

Vicia tetrasperma (L.) Mch. — I, 810.—
5256) Masslak, 4.VI.1908 (fruits). Nouveau pour le Bosphore.

Cicer Montbretii Jaub. et Sp. — I, 795.—
4123) Baltaliman, 4.VI.1908 (fleurs et fruits).

Lathyrus inermis Roch. — I, 819.—
5241) Bois de Djirdjir, 24.VI.1908 (fruits).
var. *glabriusculus* (Ser.)
Baltaliman, 4.VI.1908 (fleurs).

LINACEAE

Linum angustifolium Huds. — I, 565.—
5448) Kanli Kavak, 4.VI.1908 (fleurs et fruits). Det. B. Post.

Linum bithynicum Azn. (à comp. fig. 2 (p. 28) dessinée d'après les échantillons d' Aaronsohn).
5426) Tchamlidja, 22.V.1908 (fleurs et fruits). Det. B. Post, qui nous écrit sur la distribution de cette espèce: "Not uncommon in the hilly regions on the Asiatic side of the Bosporus. The very scabrous-margined leaves readily distinguish it from all other species of the region except *L. tenuifolium* which has scabrous margined leaves, but is otherwise markedly different".

POLYGALACEAE

Polygala vulgaris L. — I, 596.—
5619) Masslak, 4.VI.1908.

EUPHORBIACEAE

Euphorbia stricta L. — I, 125.—
5704) Forêt de Belgrade, 5.VII.1908 (fleurs et j. fruits).

Fig. 2. *Linum bitfiynicum* Azn. — a. Port de la plante. — b. Fleur. — c. Pétale isolé, glanduleux. — d. Intérieur de la fleur. — e. f. Semences. — G. Capsule.

Dessin : E. Stein — Jérusalem

Lavandula pedunculata, var. *cariensis*, poussant à Masslak (Bosphore).
Photo Dr. K. Aulich — Istanbul.

EVENARI AND OPPENHEIMER — RELIQUIAE AARONSOHNIANAE III

Salvia Forskahlei végétant à Anadolou Hissar.

Photo Dr. K. Aulich – Istanbul

EVENARI AND OPPENHEIMER — RELIQUIAE AARONSOHNIANAE III

ANACARDIACEAE

Pistacia mutica F. et M. — I, 599.—
5796) Tchenghelkeuy, 15.V.1908 (jeunes fruits).

ACERACEAE

Acer platanoides L. — I, 607.—
5839) Forêt de Belgrade, 5.VII.1908.

TILIACEAE

Tilia tomentosa Mch. (=*T. argentea* Desf.) — I, 555.—
5969) Djirdjir, 24.VI.1908 (fleurs). — 5968) Forêt de Belgrade, 5.VII.1908 (fleurs et j. fruits).

RHAMNACEAE

Paliurus Spina Christi Mill. — I, 616. —
5893) Kiat Hané, 5.VI.1908 (fleurs).

GUTTIFERAE

Hypericum calycinum L. — I, 531.—
*10517) Bois de Djirdjir, 23.V.1908 (fleurs). — 10519) Forêt de Belgrade, 15.VII.1908 (fleurs).

Hypericum bithynicum Boiss. — I, 541.—
10501) Entre Masslak et Kanli Kavak, 4.VI.1908 (fleurs et j. fruits.)

Hypericum rhodopaeum Friv. — I, 542.—
10520) Tchamlidja, 22.V.1908 (fleurs).

LYTHRACEAE

Lythrum Salicaria L. — I, 938.—
6166) Forêt de Belgrade, 5.VII.1908 (fleurs).

ONAGRACEAE

Circaea lutetiana L. — I, 949.—
10527) Bois Djirdjir, 24.VI.1908 (fleurs et j. fruits).

UMBELLIFERAE

Scandix Pecten Veneris L. — I, 1065.—
? var. *laevigata* Azn.
6416) Tchenghelkeuy, 15.V.1908.

Conium maculatum L. — I, 1069.—
Djirdjir, 24.VI.1908.

Oenanthe pimpinelloides L. — I, 1014.—
6363) Forêt de Belgrade, 5.VII.1908 (fruits).

Tordylium byzantinum (Azn.) Hayek — I, 1045.—
(=*Ainsworthia byzantina* (Azn.) =*Ainsworthia cordata* Boiss).
*6182) Tchenghelkeuy, 15.V.1908 (fleurs).

Ainsworthia trachycarpa Boiss. fl. or. — II, 1035.—
6186) Yédi Koulé, 14.VI.1908.

Orlaya platycarpa (L.) Koch — I, 1053.—
6374) Tchenghelkeuy, 15.V.1908 (fruits).

CORNACEAE

Cornus australis C.A.M. — I, 954.—
6492) Forêt de Belgrade, 5.VII.1908 (fruits).

ERICACEAE

Arbutus Unedo L. — II, 18.—
1546 z) Forêt de Belgrade, 5.VII.1908. Det. B. Post.

Erica arborea L. — II, 20.—
7660) Djirdjir, 24.VI.1908 (fruits).

PRIMULACEAE

Lysimachia punctata L. — II, 32.—
7460 b) Forêt de Belgrade, 5.VII.1908 (fleurs). Det. B. Post.

OLEACEAE

Ligustrum vulgare L. — II, 439.—
6606) Baltaliman, dans les haies, 4.VI.1908.
6165) Forêt de Belgrade, 5.VII.1908 (jeunes fruits).

GENTIANACEAE

Erythraea Centaurium (L.) Pers. — II, 414.—
6657) Djirdjir, 24.VI.1908 (fleurs).

CONVOLVULACEAE

Calystegia sepium (L.) R. Br. — II. 40.—
6753) Baltaliman ,4.VI.1908 (fleurs).

BORAGINACEAE

Borago officinalis L. — II, 57.—
6913) Bords des routes, Tchamlidja, 22.V.1908.

Lithospermum arvense L. — II, 81.—
*7026) Tchenghelkeuy, 15.V.1908 (fleurs et fruits).

Onosma arenarium W. K. — II, 87.—
(= *O. echioides* Boiss.)
7087) Tchamlidja, 22.V.1908 (fleurs). Det. B. Post.

LABIATAE

Lavandula pedunculata Cav. — II, 253.—
var. *cariensis* (Boiss.) Bth.
*7222) Masslak, 4.VI.1908 (fleurs).
A comparer le photo [Tabl. (Plate) I] pris par le docteur K. AULICH à Masslak.

Origanum vulgare L. ssp. *eu-vulgare* Hayek.
var. *puberulum* Beck — II, 334.—
San Stefano (= Yeshilkeuy), terres fortes, bords des marais, 21.VI.1908 (fleurs).

Thymus Callieri Borb. — II, 364.—
7578) Tchamlidja, 22.V.1908 (fleurs) Teste K. Ronniger.

Thymus thracicus Vel. — II, 347.—
7585) Tchamlidja, 22.V.1908. Det. K. Ronniger.

Salvia Forskahlei L. — II, 309.—
7456) Djirdjir, 24.VI.1908 (fleurs). A comparer [Tabl. (Plate) II]

Salvia virgata Ait. — II, 10.—
· San Stefano (= Yeshilkeuy), 21.VI.1908. (fleurs).

Scutellaria albida L. — II, 251.—
7371) Forêt de Belgrade, 5.VII.1908 (boutons).

Prunella laciniata L. — II, 265.—
*7183) Masslak, 4.VI.1908 (fleurs).
7547 A) ? Djirdjir, 24.VI.1908 (fruits). (= var. *integerrima* Beck).

Prunella vulgaris L. — II, 264.—
7461) Forêt de Belgrade, 5.VII.1908 (fleurs).

Marrubium vulgare L. — II, 255.—
7228) Kanli Kavak, 4.VI.1908 (fleurs).

Stachys cretica L. — II, 283.—
ssp. *bulgarica* K. Rechinger fils.
7520) Kanli Kavak, 4. VI.1908. Det. K. Rechinger fils. Nouveau pour le Bosphore.

Teucrium Chamaedrys L. — II, 245.—
7547) Djirdjir, 24.VI.1908 (fleurs).

SCROPHULARIACEAE

Celsia bugulifolia (Lam.) Chaub. et Sp. — II, 134.—
7810) Tchamlidja, 22.V.1908.

Linaria genistifolia (L) Mill. — II. 142.—
*7890) Baltaliman ,4.VI.1908 (fleurs).
*7889) Kiat Hané, 5.VI.1908 (boutons).

Scrophularia Scopolii Hoppe — II, 148.—
7995) Masslak, 4.VI.1908 (fleurs et fruits).

Scrophularia canina L. — II, 152.—
7942) Tchenghelkeuy, 15.V.1908 (fleurs).

Veronica pectinata L. — II, 171.—
*8046) Tchamlidja, 22.V.1908 (fruits).

Veronica Tournefortii Gmel. — II, 163.—
*8030) Masslak, 4.VI.1908 (fleurs et fruits).

PLANTAGINACEAE

Plantago lanceolata L. — II, 404.— ssp. *communis* Schldl.
8289) Yedi Koulé, 14.VI.1908 (fleurs).

Plantago Bellardi All. — II, 410.—
8261) Tchamlidja, 22.V.1908 (fleurs et fruits).

Plantago Coronopus L. — II, 410.—
var. *vulgaris* Gr. et Godr.
8184) Djirdjir, 23.V.1908 (fleurs).
var. *simplex* Boiss.
8290) Ok Meidan (?), 17.V.1908 (fleurs).
var. *commutata* (Guss.) Bég.
*8262) Tchenghelkeuy, 15.V.1908 (fleurs).

RUBIACEAE

Sherardia arvensis L. — II. 442.—
ssp. *mutica* (Wirtg.) Azn.
*8457) Tchenghelkeuy, 15.V.1908 (boutons).

Galium verum L. — II, 462.—
8385) Djirdjir, 24.VI.1908 (fruits).
8389) Forêt de Belgrade, 5.VII.1908 (fruits).

Galium Cruciata L. — II, 473.—
8319) Bois de Djirdjir, 23.V.1908 (fruits).
8321) Masslak, 4.VI.1908 (fleurs).

CAPRIFOLIACEAE

Lonicera etrusca Savi (in Santi) — II, 481.—
var. *Roeseri* Heldr.
8484) Djirdjir, 24.V.1908 (fleurs) Det. B. Post.

DIPSACEAE

Scabiosa maritima L. — II, 515.—
8627) San Stefano (=Yeshilkeuy), 21.VI.1908 (fleurs et fruits).
8601) Kanli Kavak, 4.VI.1908 (fleurs). Exemplaire douteux.

CAMPANULACEAE

Campanula lyrata Lam. — II, 525. —

8665) Kanli Kavak, 4.VI.1908 (fleurs)

8660 A) Djirdjir, 24.VI.1908 (fleurs).

Campanula persicifolia L. — II, 544.—

8663) Baltaliman, 4.VI.1908 (fleurs).

Campanula Rapunculus L. — II, 547.—
var. *Lambertiana* Boiss. (f. *laciniis calycis distincte pinnatifidis*).

***8664**) Baltaliman, 4.VI.1908 (fleurs).

Legouzia (*Specularia*) *pentagonia* (L.) Thell. — II, 551.—

8744) Yédi Koulé, 14.VI.1908 (fruits).

***8759**) Tchenghelkeuy, 15.V.1908 (fleurs) *forma patule hirsuta.*

COMPOSITAE

Filago germanica L. — II, 591.—

9252) Djirdjir, 24.VI.1908.

Pulicaria odora (L.) Rchb. — II, 608.—

9329) Entre Kiat Hané et Férikeuy, 5.VI.1908 (fleurs).

Pyrethrum Parthenium (L.) Sm. — I, 651.—

***9493**) Rouméli Hissar, 4.VI.1908 (fleurs).

Senecio Castagneanus DC. — II, 673.—

***9497**) Tchamlidja, 22.V.1908 (fleurs).

Cirsium arvense (L.) Scop. — II, 719.—
var. *vestitum* W. et Grab.

9103) Yedi Koulé (fleurs et fruits). Probablement nouveau pour le Bosphore.

Crupina Crupinastrum Vis. — II, 733.—
Yédi Koulé, 14.VI.1908 (fleurs et fruits).

Zacyntha verrucosa Gaertn. — II, 806.—

9603) Masslak, 4.VI.1908 (fleurs et fruits).

AN ACCOUNT OF THE VEGETATION OF THE HULEH SWAMPS

By H. R. OPPENHEIMER

The Huleh region can be divided into three different districts. The northern part consists of a moist lowland. Here tree growth is possible, as demonstrated by the presence of large specimens of *Pistacia atlantica Desf.* The southern part includes the Merom lake. Between those two portions extends the central transition region, which is marshy in nature. It consists mainly of a reedy *Papyrus* bog (Gruenmoor, Niederungsmoor). This central region extends over some 30 to 40 squ. km. Through it the Jordan river flows, which is here only a few meters wide. From the phytogeographical point of view this part is a *terra incognita* within the otherwise well explored Syro-Palestinian region.*)

The writer visited the Huleh swamps on August 24th, 1937 and had opportunity to study its vegetation upon invitation by the Huleh Concession Company, which took over the drainage of this territory in order to prepare it for agricultural settlement.

We reached the mouth of the Jordan river by boat over Lake Merom from the South and observed on the northern shore a *limnion* zone of water lilies (*Nymphaea, Nuphar*). This zone is some few hundred meters to 1 km. wide and represents an outpost of the swamp vegetation which gradually conquers the northern part of the lake. Entering the Jordan river we observed a strip of *Polygonum acuminatum* KUNTH several meters in width, bordering the shore of the lake and the Jordan river. Immediately behind those *Polygonum* plants we noticed the first stands of *Cyperus Papyrus* L. *var. palaestina*

*) Informations about the Huleh flora are found in the Flora of POST (2nd edition by DINSMORE), in EIG's early publications, in the "Analytical key to the Flora of Palestine" by EIG, ZOHARY and FEINBRUN and in the writer's "Esquisse de géographie botanique de la Transjordanie" (Bull. Soc. Bot. Genève, 22 (1930), p. 422).

CHIOV. This *Papyrus* doubtlessly represents the dominant of the principal association of this region according to its size and abundance. It reaches a height of some 3 to 4 meters and is used by the natives for the manufacture of mats. This and fishing form, indeed, the principal sources of income of the native Huleh population ("Ghawarni" in Arabic). In addition to *Papyrus* we find on the banks of the Jordan the same facies as on the shore of the lake, with *Polygonum acuminatum* as dominant and *Jussiaea repens* L. as a subdominant. *Polygonum* grows to about 1 meter in height. *Phragmites communis* TRIN. forms here and there near the Jordan facies of minor extension and does not seem to form a major constituent of the vegetation along the stream. We also noticed willows (*Salix? alba* L.) while *Populus euphratica* OLIV., which is so widespread on the banks of the lower Jordan, seemed to be absent. Furthermore we observed *Lythrum Salicaria* L., *Mentha longifolia* (L.) HUDS, *Lycopus europaeus* L. (with deeply sinuate leaves as in Europe), *Pulicaria dysenterica* (L.) GAERTN. and *Eclipta alba* L. Tall perennials striking the eye are *Cyperus alopecurus* ROTTB. and *Typha angustata* BORY et CHAUB. Both attain a man's height. Next in height are *Juncus inflexus* L. *var. glaucus* (EHRH.) FIORI and *Rumex conglomeratus* MURR. The latter was only evidenced by dry fruit bearing inflorescences at that time of the year. *Alisma lanceolata* WITH. was likewise fruiting, while *Sparganium erectum* L. was still green, but already past flowering. *Sparganium* follows the banks of the river, where we also noticed various low reed grasses such as *Cyperus fuscus* L., *C. longus* L. (scarce) and *Fimbristylis dichotoma* ROTTB. We did not, however, collect any species of *Carex*. The creepers *Calystegia sepium* L. and the beautiful Asclepiadacea *Cynanchum acutum* L. are found climbing on *Papyrus* and the *Phragmites* reed. At places projecting above the water level one finds true grasses such as *Echinochloa crus galli* L. *var. longiseta* (TRIN.) and *Digitaria sanguinalis* (L.) SCOP. Especially the former is common and reaches as high as 1.5 meters. In the Jordan we found *Myriophyllum spicatum* L.

The Jewish workers of the Company had just carried out the first step of their work by cutting passages into the dense *Papyrus* jungle which extends on both banks of the river. These passages follow a direction perpendicular to the course of the river Jordan i. e. East-West. They offer a first opportunity to penetrate into the dense

vegetation. Over those cut trails we entered the jungle easily,, walking on the cut down stems of the *Papyrus*. Only occasionally the feet sunk in into the water.

In passage E, located about 1.5 km. south of the northern limit of the swamps and extending from the Jordan for about 400 meters eastward, we found an extremely uniform vegetation, composed of only three species. It represents an association which may be designated as *Papyreto-Polygonetum*. This association possesses a pronounced vertical differentiation. *Papyrus*, forming the upper stratum, is dominant (2.5 to 3 meters high), *Polygonum acuminatum* growing in its shade is sub-dominant. Its ochrae possess mostly rather long ciliae. At less shady locations the leaves are densely covered with appressed, silky hair. The third, rather suppressed species of the association is *Pteridium aquilinum* (L.) KUHN. Probably because of its shady habitat, its fronds are only poorly developed and the stems weak and thin. While *Papyrus* does not occur north of the Huleh within the limits of the region described in Post's Flora, *Pteridium* attains here a regional southern boundary of distribution: we do not find it elsewhere, neither in Palestine nor in the Sinai. Under these circumstances the occurrence of both species in the same association is of considerable phytogeographical interest.

In passage F, on the western side of the Jordan, opposite the passage just described, we found exactly the same vegetation as in passage E, augmented by *Lythrum salicaria*, which was at the time of our visit in full bloom. This species occupies open places in the *Papyretum*, originated by the clearing of the *Papyrus*. Its success may me dut to a change in moisture conditions no longer favouring the reproduction of the *Papyreto-Polygonetum* which is adapted to constant submersion of the rhizomes. Where, on the other hand, regeneration of the *Papyretum* had taken place, the stems did not attain their previous height. While the undisturbed Papyri were 3.5 meters high, the regenerated ones attained only 2 meters (Pl. III).

Returning downstream southward, our boat stopped at a place at which the river turns toward the South-East. Here a quite different vegetation had developed, which probably owes its presence to the fluvial deposition of mineral soil particles, a process which has led here to a local elevation of the right bank. The vegetation found in this region (Pl. IV) was remarkable for the complexity of its compos-

Fig. 1. Entrance to the Jordan river, where it empties into Lake Huleh. *Polygonum acutifolium* on the banks, *Papyrus* immediately behind.

Fig. 2. Regeneration of cut-down *Papyrus* on the banks of the Jordan. Notice the low size of the regenerated stems in comparison to the undisturbed stand in the background.

Fig. 3. Facies with *Lythrum Salicaria* as a dominant on the right bank of the Jordan.

ition due to the spotty edaphic variations. We propose to designate this facies as *Lythretum Salicariae,* although *Lythrum* was not dominant everywhere. Conditions of existence are here favourable for so many species that a very heterogenous distribution pattern results. In other words we are dealing here with a mere aggregation of individuals rather than with a typical consociation with preponderant dominants. We noted in this region, only a few meters from the Jordan, the following species:

Species	Stage of developmt.	Abundance-dominance	Remarks
Lythrum Salicaria L. *var. tomentosum* MILL.	fl	2	ca. 1½—2 meters high
Melilotus albus MED. *var. parviflorus* BOISS.	fl	2	ca. 2.5 meters high
Bidens tripartita L.		+	
Alisma lanceolata WITH.	fr.	+	
Epilobium hirsutum L. *var. tomentosum* VENT.	fl.	+	ca. 2 meters high
Plantago maior L.	(young fr.)	1	forming part of a special vegetation component of the low herb layer.
Pteridium aquilinum (L.) KUHN		1	
Veronica? Anagallis aquatica L.	fl.	+	
Lycopus europaeus L. (*typicus foliis lobato-dentatis*)		+	
Digitaria sanguinalis (L.) SCOP.		+	
Verbena officinalis L.		+	
Rumex conglomeratus MURR.		+	

Aside from these we also noticed *Cyperus Papyrus* and *Polygonum acuminatum*, both evidently in a weak condition and unable to compete here with the tall herbs of the facies, especially with *Lythrum*, *Epilobium* and *Melilotus*, the soil moisture requirements of which are less extreme. A striking feature, observed with *Polygonum*, was the drying up of the lower leaves, a condition which had not been observed in the swamps even under conditions of very insufficient illumination. In this region *Papyrus* formed flowers after having scarcely reached a man's height.

Another plant, which was observed, was a species of *Galium*, resembling closely *Galium palustre* L., which is so widespread in swampy localities in Europe. As no ripe fruits were available, we were unable to decide, whether the collected specimens are identical with *G. palustre*. This species was not as yet reported to have been found in this region. We noticed the same *Galium* later creeping on *Papyrus* in boggy soil as an accessory element of the *Papyreto-Polygonetum*. Its cymes originate in the leaf axils and are not arranged in a terminal panicle, a character which does not seem to agree with *Galium palustre*. Like *Polygonum* and *Pteridium* it belongs to the undergrowth (herb stratum) of the association.

Still farther south we visited the passages C and D. Here again we saw the typical *Papyreto-Polygonetum* with *Pteridium* and *Galium*. Patches of *Typha angustata* were scattered between the majestic stands of the *Papyretum*, which attained as much as 4 meters in height.

Meanwhile noon was over. A refreshing wind sprang up after the usual, calm forenoon, which mitigated the oppressing moist heat reminding us of the climatic conditions of tropical countries. Our boat moved again southward. We noticed that *Phragmites* was here more frequent, forming patches within the *Papyretum*.

Arriving in one of the most southern passages, A, which lies on the Transjordan side, we were surprised to find a quite different picture. Not far from the river the *Papyretum* was completely receding before an almost pure stand of *Cladium Mariscus* (L.) R. BR. which reaches here the extraordinary size of about 2.50 meters. The *Cladietum* was extremely dense and seemed to exclude all competitors. Only a few specimens of *Papyrus*, *Lythrum* and *Pteridium* were found growing in it. It would seem to extend eastward to a considerable distance. At an open place near the Jordan we found the soil covered with a carpet of *Lippia nodiflora* L. which we had not noticed before.

In Passage B, on the other side of the river, we found an *Urtica*, which was not yet in bloom, apparently *Urtica pilulifera* L. This species, which is rather widespread in Palestine, seems to be an indicator of better light conditions, similarly as *Lythrum Salicaria*. Here we also found a young fig tree about 2.5 meters in height.

Summing up our observations, we wish to state:

The flora of the Huleh swamps is a mixture of cosmopolitan, boreal and tropical hygrophytes. Halophytes seem to be completely absent. This corroborates results of soil investigations carried out by the Division of Agricultural Chemistry at the Agricultural Research Station which failed to detect the presence of common salt in the Huleh peat. The principal association in the Huleh swamps is a *Papyroto-Polygonetum* which is adapted to a very high water level. It also forms the bulk of the peat. The region, where this association is found, is covered with water during winter and spring. At localities where the *Papyretum* has been cleared by the inhabitants (or by fire) the *Papyretum* regenerates itself if the water level is sufficiently high. If this is not the case a *Lythretum* seems to originate as a successional interphase. A different flora was found on one bank of the river, which owes its existance to a higher elevation above the water level, possibly formed by the deposition of alluvial soil. It is composed of glycophytes such as grasses, *Plantago maior* and leguminous plants such as *Melilotus*.

This territory represents now the most interesting remnant of untouched fresh water flora and fauna in our region. The essential problem concerning its agricultural utilisation is of course the effect which an artifical lowering of the water level would have upon the flora. We are convinced that the *Papyretum* will easily disappear giving way to a *Lythretum* and similar associations which we find now in parts of the Kabbara swamps near Caesarea drained about 10 years ago. Probably various grasses and leguminous plants will establish themselves which might be of value as pasture for cattle. The value of the region for agricultural settlement depends, however, principally upon the future rate of decomposition of the black Huleh peat which at many places forms a stratum several meters thick. Nothing is known so far about this important problem.

EXPERIMENTS ON THE CONTROL OF ALBINISM IN CITRUS SEEDLINGS

By J. PERLBERGER and I. REICHERT

(Division of Plant Pathology, Agr. Res. Sta., Rehovot).

Introduction

Albino or white seedlings are known to develop in seed beds of different citrus varieties (Pl. V). These seedlings succumb after a short time. The exact loss suffered by the nurseryman because of this trouble is not known. Our investigations show that in Palestine albino seedlings are responsible for a considerable loss, reaching as high as 74% of the seeds sown. Because of this trouble there is a great loss of expensive seeds, carefully prepared nursery space and seedlings. So far as we know, no remedy for the control of albinism has ever been suggested.

In the course of our investigation on the prevention of parasitic diseases in citrus seed beds (15, 16) we carried out some experiments on the disinfection of Sweet Lime and Sour Orange (Hushhash) seeds. We were surprised to find that in seed beds sown with seeds that had been disinfected by certain means, no albinos appeared. This discovery led us to undertake a detailed investigation of the problem, the results of which are reported below.

Types of albino seedlings

Sweet Lime, Sour Orange, Grapefruit and Rough Lemon seed-beds examined contained chlorophyll-lacking seedlings of various forms and colours. Some seedlings were yellowish-white, others yellowish, and still others partly white and partly green. In some cases the stem was white and the leaves were green, and in others the stem was green and the leaves yellowish or whitish. The leaves also were not always of one colour. At times the mesophyll only

was yellowish-white, and the veins green, and occasionally the reverse occurred. Sometimes only one leaf out of two or only part of the two leaves were green, whereas the remainder of the seedling was white. (Pl. VI). Generally the first two leaves of the albino seedlings were white. A third white leaf might appear, but rarely would a fourth leaf develop and this would be small and narrow. We have found solitary cases where the third and fourth leaves were green. Albino seedlings of any kind cannot survive in the field in the direct light of the sun. Such plants degenerate in the course of a few days. When they are grown in the shade or transplanted to a shady spot, a closed room, for instance, they may be kept alive for 5—8 weeks.

Responsible agents

Microscopic examination did not reveal the presence of micro-organisms. In order to ascertain whether albinism of citrus seedlings might be the result of an infectious principle such as virus, a number of experiments were carried out. The seed coats and cotyledons of Sweet Lime seeds were pricked a number of times with a sterile needle. The seeds were then immersed in the expressed juice of albino seedlings for one hour and sown. The number of albino seedlings resulting was not greater than in the control (Table XXIII). In another experiment an attempt was made to infect green leaves of ten normal seedlings by rubbing them against the leaves of albino seedlings. This experiment also gave negative results. Further experiments in this direction are still to be made.

Number of albino seedlings

The number of albinos in Sweet Lime seed beds is not constant. In Table I the figures obtained in the seed beds of the Division of Physiology and Genetics in the winter of 1931, are presented. In these beds seeds from fruit of 11 trees from groves of different localities were sown. The figures indicate that the percentage of albinos among the Sweet Lime seedlings sown in the seed beds is very variable, ranging from 10.2—37%.

In seed beds sown by the Division of Physiology and Genetics in 1929/30 for the purpose of the clarification of the effect of the size of fruit and seeds on the number of albinos, it was found that from 2.5 to 64.2% of white seedlings occurred. (Tables II, IIa,

IIb, IIc). In other seed beds such as those set up in Nes Tsiyona in 1934—35, the percentage of albinos in seed beds amounted to 62.8% (Table VII). The highest percentage of albinos recorded by us, however, appeared in the seed beds of Bnei-Brak in 1929—30. In these seed beds the albinos constituted fully 74% (Table III).

In Sour Orange seed beds the percentage of albinos is smaller. In 1930—31 the percentage of albinos in such seed beds ranged from 2 to 12% and in 1934 from 0 to 3% (Table IV, IVb). It should be noted, however, that our data on Sour Orange seed beds are slight.

EXPERIMENTAL RESULTS

In order to elucidate the controlling effect of disinfectants upon albinism, we set up a series of field experiments, running for several years in various parts of the country. In addition, for the purpose of obtaining more accurate results, some better controlled experiments were carried out in the laboratory.

FIELD EXPERIMENTS

1. *Methods*:

The field experiments were arranged as follows: In sandy-clay soil, of the kind generally used in seed beds, a known number of non-disinfected and disinfected seeds treated with one or several disinfectants were sown. In the course of twelve weeks, the number of albinos and green plants among the seedlings was recorded. The final count was taken about twelve weeks after sowing.

Two methods of treatment were used:

a) Dipping of seeds for 20 minutes in various concentrations of disinfectant solutions before sowing.

b) Treatment with disinfectant solutions of soil sown with untreated seeds. The soil was watered with four litres of the solution per square meter 10 days before sowing.

2. *Results*:

In Tables III to IX the results of the field experiments are summarized. The figures of Table III indicate that in Sweet Lime seeds beds in which the seeds were treated by dipping in Germisan, Uspulun or dusted by Abavit no albinos appeared. In seed beds Nos. M/86 and M/90, the seeds of which had not been disinfected, the albinos comprised 39% and 74% respectively of the total

number of germinated seeds. From Table VII we learn that in seed beds of seed disinfected with Ceresan, the percentage of albinos ranged from 0 to 12.6% whereas in seed beds which had been sown with untreated seeds the percentage of albinism ranged from 28.6—62.8%. The isolated cases of the appearance of albinos among disinfected seeds, in experiments carried out on a large commercial scale by private nurserymen, may perhaps be attributed to the fact that these seeds were disinfected in large numbers in the same vessel at one time. Sweet Lime seeds are frequently light and float on the surface of the solution, thereby escaping immersion. Even in these cases, however, the percentage of albinos among seedlings whose seeds had not been disinfected was 2—5 times as great as that among the seedlings of treated seeds.

It is noteworthy that in all other seed beds the percentage of albinos from disinfected seeds did not exceed 2%. The experimental data presented in Table VIII show that the disinfection of seeds with 1:1000 Ceresan reduced the percentage of albinos from 29.6—68% to 0—1.3%. Also in the seed bed experiment reported in Table IX the percentage of albinos was reduced from 25.1—26.9% to 1.6—3.6%.

In Sour Orange seed beds as well, a considerable reduction in the appearance of albinos may be effected by treatment with the above-mentioned disinfectants. Table IV indicates a reduction of the percentage of albinos to zero in seed beds sown with seeds treated with Uspulun or Abavit, whereas seed beds sown with seeds which had not been disinfected contained 9—12% albino seedlings. No improvement was observed in seeds treated with Germisan. The seeds, which had been dipped in 1/8 or 1/4% solutions of Germisan gave 6—9% albinos.

In addition to the above quoted records we may mention that in many nurseries in Hadera, Petah Tiqva and Kinnereth, where, according to our advice, seeds were treated with Uspulun and Ceresan the seed beds became practically free of albinos. Unfortunately, we were not able to make exact counts in these seed beds.

On the strength of the data presented here, we may conclude that by the disinfection of seeds with the above-mentioned disinfectants albinism may be prevented or reduced in field seed beds.

As far as the question of treatment of soil with disinfectant solutions is concerned, it is evident that solutions of Uspulun, Germisan and Ceresan generally do not prevent the development of albinos. In Table III we see that in Sweet Lime seed beds Nos. 93 and 94 the percentage of albinos, after soil disinfection with Uspulun, ranged from 40—47%, while after treatment with Germisan only 4—12% of albinos appeared in seed beds M/91 and M/92. In seed beds of Sour Orange, Nos. 105—108, as Table IV indicates, the percentage of albinos in soil disinfected with Germisan was 2—3%, and with Uspulun from 8—12%. In seed bed No. 8, reported in Table VII, whose soil was treated with Ceresan solution 1:5000, the albino percentage varied from 38.8—55.4%. Table IX also shows that in seed beds Nos. 63a and 64a, in soil disinfected with Ceresan solution, 1:4000, the percentage of albinos was 25—26 9%, — that is not less than in the untreated seed beds or those treated with Formalin.

From Tables IVa and IVb we may see that seeds of Sweet Lime and Sour Orange, sown in soil treated with Uspulun and Ceresan, produced, probably by coincidence, more albinos than in untreated soils. In soils treated with Uspulun the Sweet Lime seeds showed 6% of albinos, whereas in untreated soil, only 2% appeared. Among the seed beds treated with Ceresan, 2% of albino Sweet Lime seedlings were found while the untreated soils were all free of albinos. Sour Orange seeds sown in soil treated with Uspulun showed, in one seed bed, 3% of white seedlings, whereas untreated soils were free from them. It is to be remarked that the number of albinos appearing in all these cases was very low.

In these seed beds the percentage of albinos decreased when, in addition to the soil, the seeds also were disinfected (Table III, IVa, VII and IX). The experiments show that disinfectants, when applied only to the soil, are not on the whole effective in eliminating albino seedlings.

In order to determine the effect of disinfecting the soil at different times before or after sowing, we treated the soil with Ceresan solutions of strengths 1:4000, 1:3000, 1:2000 and 1:1000 as follows: (1) two weeks before sowing, (2) on the day of sowing and (3) a day after sowing. As seen in Table V for unknown reasons, under all the varied conditions, the percentage of albinos

(a) (b.)

Seedbed of citrus seedlings

(a) Control: part of a seed bed, sown with untreated seeds, showing a large percentage of albinos.

(b) Part of the same seed bed sown with seeds treated with Uspulun. No albinos occurred.

PERLBERGER AND REICHERT — ALBINISM IN CITRUS SEEDLINGS

Different types of albino seedlings.

PERLBERGER AND REICHERT — ALBINISM IN CITRUS SEEDLINGS

Laboratory experiment in germination tins.
The seeds were treated with different concentrations of Uspulun. Only the control (upper right hand tin), the seeds of which were treated with distilled water, produced albino seedlings.

PERLBERGER AND REICHERT — ALBINISM IN CITRUS SEEDLINGS

was, on the whole also very low: 2—5%. In the plot, sown with seeds disinfected with Ceresan solutions 1:1000, 1:2000 and 1:3000, the percentage of albinos was reduced to 0.5—2%.

Laboratory experiments

1. *Methods*:

The laboratory experiments were so arranged as to enable us to maintain uniform external conditions during germination. For this purpose, we sowed the seeds in clean sand which we had heated in conc. hydrochloric acid and washed free from chlorine. For containers we used rectangular zinc tins (15×20 cm. and 6 cm. high). Each tin was provided with two partitions dividing it into three parts: one large central compartment and two narrow divisions on either side, each of the latter being 1.5 cm. in width. A narrow slit separated the base of each partition from the bottom of the tin. In the central compartment the clean sand was poured to a depth of 4 cm. and the adjoining side compartments were filled with the quantity of water necessary for wetting the sand. The water reached the central compartment through the slits at the bottom of the partitions. (Pl. VII). Experience taught us that the quantity of water which gives the best conditions for germination of citrus seeds is 10% of the weight of the sand. This was the amount of water applied in all the experiments with the one exception specially marked in the table. In order to maintain a constant soil humidity throughout the experiment, we weighed the tins together with the seeds every two days and each time replaced the amount of water which had evaporated. During the first 26 days the tins were covered with glass which was removed only after the seedlings had grown to a height of 2—3 cm. Citrus seeds need about 21 days to germinate at a temperature of about 24°C. We therefore took our first count 21 days after sowing and subsequently repeated the count at intervals of three days for a period of eight weeks. The appended table only contains the final figures expressed in percentages. The temperature of the room in which the seedlings germinated was maintained at 18—24°C.

2. *Results*:

The main object of these experiments was to ascertain the total percentage of albino seedlings in relation to the number of seeds sown and to the number of germinated seeds as well as the con-

trolling effect of disinfectants on their appearance. Our field experiments had not given very consistent or clear results in this respect since in the field, the percentage germination may be low at times. It might be also argued, that in seed beds whose seeds had been disinfected, only those seeds which could form green seedlings germinated, whereas seeds that could not develop into green plants failed to germinate.

Table X shows that of 50 or 100 Sweet Lime seeds dipped in tap water or distilled water, the percentage of germination was 91—100%, and of these 2—66% were albinos, whereas in the seeds disinfected with all concentrations of Ceresan and the more concentrated solutions of Uspulun, albinism was greatly reduced (1—6%). In the seeds dipped in dilute solutions of Uspulun (1/32%), the reduction was less marked, namely 26%.

Similar results showing a decided reduction of albino seedlings were observed with seeds of Sweet Lime in another set of disinfection experiments, using Ceresan and Uspulun. In Table XIX, Nos. 21—23, there were 0—2% of albinos in the treated seeds and 24% in the untreated. In Table XX, Nos. 38—41, there were 0% in the treated and 3—8% in the untreated; and in Table XXII, Nos. 136—141, there were 0—1% in the treated seeds and 8—11% in the untreated.

We find similar results for Sour Orange seeds immersed in Uspulun in Table XI. The albinos constituted 4—26.5% in the untreated seeds and 0—1% in seeds which had been dipped in Uspulun.

EXTERNAL CONDITIONS

From experience we knew that the occurrence of albinos in seed beds was not constant. From seeds of the same origin sometimes few and at times many albinos developed. This observation led us to examine the effect of external conditions on the production of albinos in the seed beds.

We attempted to obtain germination of Sweet Lime seeds under different external conditions and in this way obtain an insight into those conditions which may govern albinism. We examined the following factors: (a) type of soil; (b) soil humidity; (c) aeration of soil and depth of sowing; (d) degree of maturity of seeds and fruit; (e) place of origin of seeds; (f) origin of fruit and seeds and; (g) size of fruit and seeds.

(a) *Type of soil*:

We sowed Sweet Lime seeds in various soils in germination tins. The experiment was repeated twice. The soils used were pure sand (the same as had been used in the other experiments.), kurkar sand (a light soil which contains a high percentage of lime), sandy clay (a soil poor in lime, which is usually used in seed beds), and a heavy lime soil. We may conclude from the results reported in Table XII that the percentage germination in all soils differs radically. However, the difference in results between duplicate experiments with a given type of soil is sometimes greater than the difference in results obtained with two different types of soils.

Another experiment carried out in the field under various soil conditions (Table VIII) may be mentioned. In this experiment seed bed No. 1 was prepared with a soil rich in humus and seed bed No. 2 with sandy clay. In No. 1, 68.8% of albinos developed and in No. 2, 29.6% were found. From this experiment the conclusion does not follow, however, that soil rich in humus is more conducive to the production of albinos than sandy clay. This may be seen from Tables XIV, XV and XVI where experiments, using soil rich in humus in seed pots, are summarized. In these experiments we received in one field set (Table XV) an average of 24.9% of albinos, ranging from 1—77%. In a second field set (Table XVI) there were only 10.7% of albinos, ranging from 0—34%. In the third set of experiments (Table XIV), carried out in the laboratory, we received an average of 39.1% of albino seedlings, ranging from 5—75%. It is to be noted that the variations of the average percentage of albinos between the three sets and within the sets themselves were much greater than the variations between the two types of soil, given in Table VIII.

(b) *Soil humidity*:

We varied the soil humidity by watering the pure sand with various weighed quantities of water. We applied 50, 100, 200 and 250 grams of distilled water per kilogram of sand. The results summarized in Table XIIIa show that as the humidity rises, the total percentage germination falls. In the germination tins which received 250 grams of water not a single seed germinated. The percentage of albinos also fell as the humidity rose. From this experiment alone, however, we should not infer that an increase in humidity leads to

a decrease in albino seedlings as we have seen that in the above discussed Table XIV, summarizing an experiment carried out under saturated conditions (the germination pots were covered with bell jars and profusely watered), the percentage of albinos varied greatly, from 5—75%.

(c) *Aeration*:

Sweet Lime and Sour Orange seeds require good aeration for germination. When the seed beds are poorly ventilated germination is not satisfactory. This fact leads one to inquire whether aeration conditions influence the percentage of albinos. The experiment reported in Table X. Nos. 6—10, shows that with Sweet Lime seeds sown on the soil surface and left uncovered, 2% of albinos appeared, whereas in seed beds where the seeds were covered, (Table X, Nos. 1—5), the percentage of albinos was 66.6%. The experiment was repeated with Sour Orange seeds and it appears from Table XI that with seeds not covered by sand (Nos. 10 and 20) the percentage of albinos, 26.5 and 20%, is not smaller than in seeds which were covered (Nos. 5 and 15) which showed 25.9 and 4% respectively. On the contrary, the quoted Experiment No. 15 showed an even smaller percentage of albinos (4%).

Another experiment on covering seeds with sand was conducted with a somewhat different arrangement. We sowed Sweet Lime seeds in germination tins and covered them with different depths of sand layers (½, 1½, 3 and 5 cm.). As one may see from Table XIIIb the effect of aeration, which depends upon the thickness of the covering soil layer, could not be clearly established. Where seeds were covered with ½ cm. layer of sand, only 11% of albinos appeared whereas 29% developed when the layer was 5cm. thick. On the other hand, however, we found that less albino seedlings (21.9%) developed under a 3 cm. layer of sand than when seeds were covered with 1½ cm. of sand (25%).

(d) *Degree of maturity of fruit and seeds*:

In order to elucidate the influence of the degree of the maturity of the fruit and of the seed upon the appearance of albinos in the seed beds, we set up three series of experiments.

The first series of experiments was carried out in the following manner: Fruit was picked at the beginning of January. The

seeds of part of these were sown immediately and the rest of the fruit stored for four months, until April, when their seeds were sown. The results of the first sowing are summarized in Table III and those of the later sowing, in Table VI. There is no great difference between the appearance of albinos in the January sowing (4—74%) and in the April sowing (38%).

The second series of experiments was conducted as follows: One set of fruit was picked in January and divided into two parts, the seeds of one set were sown on February 25th (Table X, Nos. 1—10) and these of the other, on April 30th after two months storage (Table X, Nos. 11—20). A second set of fruit was picked from the trees in the middle of May and sown immediately (Table X, Nos. 21—23). As one may see from the results summarized in the above-mentioned tables, no difference in the appearance of albinos could be established from seed taken from fruit of various degrees of maturity. Fruit picked in January and stored for one month had 2—66% albinos (Table X, Nos. 1—10) and the same fruit stored for four months had 13—24% (Table X, Nos. 11—20). The seeds of fruit which was left on the trees until May gave 24% of albinos (Table X, Nos. 21—23).

The third set of experiments on this question was carried out according to the plan outlined in Table XVII. All the fruit was picked on the 20th of December. The seeds from a number of the fruit were removed and sown soon after picking. Some of the seeds were sown without any preliminary treatment and the others, after being dipped in water (Experiment Nos. 72—73). A second part of the fruit was stored until February 3rd and only then were the seeds removed and sown (Nos. 81—82). A third part of the fruit was stored until April 4th and then the seeds were sown (Nos. 95—96). Also in the second and third lots of the fruit, half the seeds were dipped in water before sowing.

It appears from the tables, that there is scarcely any difference in the appearance of albinos from the seeds of fruit stored for various periods. From 9—19% of albinos appeared in the seedlings from seeds which had not received preliminary treatment and from 8—11% developed from seeds which had been dipped in water.

Another experiment was carried out with the remainder of the fruit which had been picked on December 20th. The seeds were re-

moved from them on December 30th. The seeds were kept dry until sown. They were divided into four lots, each lot being sown at a different date. Before each sowing, half of the seeds were dipped in distilled water and the other half left untreated. The first sowing was on January 1st, the second, on February 1st,, the third, on March 6th and the fourth, on April 4th. As one may see from Table XVII, the sowings of March and April gave very poor germination, 0—2%, and no albinos developed. The first two sowings (January and February) gave a fair percentage of albinos, 8—11% in January and 13—28% in February. These differences are not significant as similar variations may occur in seeds planted at the same time under similar conditions.

From these experiments it may be concluded that the occurrence of albino seedlings is not governed to any extent by the degree of maturity of the fruit or seeds.

(e) *Place of origin of seeds*:

In all the laboratory experiments conducted during the years 1933—1935, which produced percentages of albinos ranging from 0—74%, we used seeds of Sweet Lime fruits, obtained from one of the groves at Rehovot. In order to discover whether the place of origin of the seeds had any effect upon the appearance of albino seedlings we made use of an experiment carried out by the Division of Physiology and Genetics. The results of this experiment are presented in Table I. We see from the table that the differences between the number of albinos developing from seeds of the same place of origin are greater than the differences in the number of albino seedlings from seeds coming from different localities. On the other hand, two other experiments, which we carried out, gave some indication of the value of the place of origin. In an experiment carried out at Nes Tsiyona we sowed in one section seeds brought from a grove in Ramleh and in another, seeds from fruit grown in Nes Tsiyona. The Nes Tsiyona seeds when sown without having been previously treated with Ceresan. gave 28—40% albinos (Table VII, Nos. 1a, 4a, 7a, 8a and 11a). Seeds from Ramleh produced 53—62.8% albinos, under similar conditions (Table VII, Nos. 1, 4. 7, 8 and 11). In another experiment conducted at Rehovot using seeds from Nes Tsiyona and Cyprus, the

former gave 50% and the latter 33—64% albinos (Table IIc). This aspect of the problem needs further study.

(f) *Origin of fruit and seeds*:

The above quoted results of experiments dealing with the seed beds prepared from seeds taken from different localities (Tables I, II, IIa, IIb and IIc), also throw light on the question of whether there is a relationship between the individual tree or the individual fruit which furnished the seed and the appearance of albinos. From our results we see that such a relationship does not exist.

(g) *Size of fruit and seeds*:

From Tables II, IIa, IIb and IIc it also appears that neither the size of the fruit nor the size of the seeds is related to the appearance of albino seedlings.

Experiments with salt solutions

In view of the fact that the active part of Ceresan, Uspulun, Abavit and Germisan is the *mercury* which these preparations contain, it appeared desirable to examine the possible action of various salts of heavy metals upon albinism. In addition, we tested a light metal compound, $Mg_2\ SO_4$, to determine whether it had an effect upon the production of chlorophyll. In a preliminary experiment (Table XIX), we used sulphates of *zinc, copper* and *iron* and a chloride of *mercury*. We were surprised to find that of all these materials only *copper* and *mercury* had an influence upon the appearance of albinos in Sweet Lime seedlings as seeds dipped in solutions of these salts gave 100% or only slightly less green seedlings.

In a second experiment along the same lines, we used other salts of heavy and light metals. To facilitate comparison we used solutions of 1/400, 1/200, and 1/100 molar concentration. It is interesting to note that of all the salts tested (Table XX, XXI), only *cobalt* nitrate and chlorides of *copper, lead, mercury* and *nickel* influenced Sweet Lime seeds to the same extent as did Ceresan, completely eliminating albinism. On the other hand, it is noteworthy that the salts of *iron, zinc, manganese* and *magnesium*, which might have been expected to stand in some relation with chlorophyll formation, exerted no influence whatsoever. It seems, on the contrary,

that these salts, as well as the salts of light metals such as *calcium, strontium* and *barium* negatively influence the seedlings and probably cause an increase in the number of albinos.

DISCUSSION

The problem of albino seedlings in citrus seed beds has not received the attention it deserves. No information has been furnished from any citrus growing region except California. FAWCETT (6), in his book on citrus diseases, makes a very short reference to this trouble, whereas FROST (7) gives the subject a more detailed discussion. PANTANELLI (14), who was one of the first to investigate the problem of albinism of plants, makes no reference to the occurrence of total albinism in citrus seedlings. He, however, makes a study of the appearance of variegated leaves on mature citrus trees.

The prevailing opinion is that albinism, in its various forms, is an inheritable factor, generally considered lethal (1), which may be linked up with the nucleus, according to the theory of BAUR (2) or with the plasma as shown by the experiments of CORRENS (4) or plastids as later suggested by BAUR (3). The only worker who deals with the genetic character of total albinism of citrus seedlings is FROST (7). He records that at times citrus albinos appeared in surprising numbers in the course of his experiments. FROST concluded from his experiments that a great part of the albino seedlings are produced apogamically and he holds the view that heterozygosis alone, does not account for the high proportion of albinos among citrus seedlings. He discusses the possibility that this apogamical production of albinos may be due to somatic variations, although he, himself, points out a weakness in this explanation because of the rarity of partial albinism in older citrus plants.

We, however, consider albinism to be an inherited constitutional characteristic of citrus plants, which may be linked up either with the nucleus or the plasma and its contents, or probably, with both together. This albinistic factor becomes manifest only under certain, as yet undefined, conditions. The citrus plants seem to react to these conditions only during the period of seed germination or it may be that these conditions prevail only at the time of germination.

Albinism of citrus seedlings must, therefore be considered a labile factor. According to BAUR's definition of genetic properties (3),

we would designate the albinistic factor of citrus as a possibility of reaction of the plant to produce albino seedlings under certain conditions prevalent in the seed bed. If these conditions are absent, the albinistic characteristic may remain latent.

The assumption of the instability of the albinistic character of citrus is borne out, on the one hand, by the irregularity of the appearance of albino seedlings in the seed beds, and on the other hand, by the fact that we succeeded in eliminating albinism by seed treatment.

It has been proved that the appearance of albinism in various cereals (11) is associated with a disturbance of the physiological functions, particularly of the enzymatic systems. Plants deficient in chlorophyll, show a marked reduction in their catalase content (5). Very likely similar disturbances take place in citrus albino seeds and seedlings. KOSTYTSHEV (10) proved that salts of heavy metals may have either an inhibitory or stimulating effect upon enzymatic systems of organisms. We may therefore assume that the treatment of citrus seeds with such salts may exert a favourable influence on the enzymatic system of the seeds, preventing the formation of albino seedlings.

In the light of these facts and considerations we cannot agree entirely with FROST in his statement, "Albinism seems to be genetic not pathological". This distinction seems to us to be inadequate. The broader definition of plant diseases, which includes those disturbances due to inherent and inheritable factors, given by KLEBAHN (9), HEALD (8), MORSTATT (12) and MUELLER (13), seems more satisfactory.

In addition, as it is an accepted fact that resistance to diseases may be a hereditary factor, it seems to follow that the susceptibility to diseases may likewise be so considered. Albinism of citrus, therefore may be described as a pathological phenomenon due to the susceptibility of the citrus plant to certain inner disturbances. Thus, in view of the irregularity of the appearance of albinos among citrus seedlings and especially because of the possibility of its prevention by seed treatment, albinism of citrus seedlings may be considered as a pathological factor.

Summary

Statistical data on the percentage of albinos appearing in citrus seed beds in Palestine are presented. It was found that the occurrence of albino seedlings is not governed by any special rule and varies from 0 to 74%.

A description of albino seedlings occurring in citrus seed beds is given.

Field experiments showed that by dipping citrus seeds in disinfectant solutions of Uspulun, Ceresan and Germisan and dusting by Abavit it is possible to eliminate entirely or reduce to a very small percentage, the number of albino seedlings.

Under field conditions, treatment of the soil with the abovementioned disinfectant solutions does not control the appearance of albinos.

Experiments carried out in the laboratory, under controlled conditions, confirmed the results obtained in the field and showed that seeds dipped in these disinfectants developed few, if any, albino seedlings. A description of the methods used in these experiments is given.

Laboratory and field experiments were carried out to determine the effect of various environmental conditions such as type of soil, soil humidity and aeration of the soil upon the appearance of albinos. The effect of the size, degree of maturity of fruit and seeds and place of their origin, as well as the origin of the individual trees and fruits were also studied. No relationship could be noticed between any of these factors and the number of albino seedlings.

In laboratory experiments it was found that dipping citrus seeds in salt solutions of *mercury, copper, lead, cobalt* and *nickel* effectively controls the appearance of albinos. On the other hand, the salts of iron, zinc, manganese, magnesium, calcium, strontium and barium exert no influence whatsoever on the number of albino seedlings.

Albinism in citrus seedlings was explained as a constitutional property inherent in the plant and becoming manifest only at the time of seed germination. This phenomenon may be due to a disturbance of the enzymatic systems of the plant at this stage. This is borne out by the fact that salts of heavy metals, which are known to have an effect upon enzymatic systems, cause citrus seeds to produce normal seedlings.

LITERATURE CITED:

1) Babcock, E. B. and Clausen, R. E. (1918). Genetics in Relation to Agriculture. New-York.

2) Baur, E. (1907). Untersuchungen ueber die Erblichkeitsverhaeltnisse einer nur in Bastardform lebensfaehigen Sippe von *Antirrhinum Majus. Ber. Deutsch. Bot. Ges.* 25: 442—454.

3) Baur, E. (1922). Einfuehrung in die experimentelle Vererbungslehre. Berlin.

4) Correns, C. (1908). Vererbungsversuche mit blass(gelb)-gruenen und buntblaettrigen Sippen bei *Mirabilis, Urtica* und *Lunaria. Zeitschr. ind. Abst.- und Vererbungslehre* 1: 291—329.

5) Euler, H. v., Forssberg, A., Runehjelm, D., Hellstrom, H. (1931). Zur chemischen Charakterisierung von erblichen Chlorophylldefekten. *Zeitschr. f. ind. Abst.- u. Vererbungslehre* 59: 131—152.

6) Fawcett, H. S. (1936). Citrus Diseases and their Control. *Second Edition*, New York.

7) Frost, H. (1926). Polyembryony, Heterozygosis and Chimeras in Citrus. *Hilgardia* 1, p. 365.

8) Heald, F. D. (1926). Manual of Plant Diseases. New York.

9) Klebahn, H. (1912). Grundzuege der allgemeinen Phytopathologie. Berlin.

10) Kostytshew, S. (1927). *Zeitschr. f. physiol. Chemie* 164: 177 (*Ref. bei* Niethammer, *Biologia Generalis*, 4, p. 660, 1928).

11) Lebedeff, A. F. (1928). Vergleichende Untersuchungen ueber einige physiologische Prozesse bei albinotischem und gruenem Mais. *Zeitschr. ind. Abst. und Vererbungslehre.* Suppl. II: 955—972.

12) Morstatt, H. (1933). Allgemeine Pflanzenpathologie. Sorauer, *Handbuch der Pflanzenkrankheiten*, Band 1, Teil 1, Berlin.

13) Mueller, K. O. (1934). Durch innere Faktoren hervorgerufene Pflanzenkrankheiten. Sorauer, *Handbuch der Pflanzenkrankheiten*, Band 1, Teil 2, Berlin.

14) Pantanelli, E. (1902—1905). Studi sull' albinismo nel Regno vegetale I—V. *Malphighia*, Vol. 15—19.

15) Perlberger, J. (1936). *Phytophthora* Stem and Tip Blight of Citrus Seedlings. *Rehovot Agr. Res. Sta.* Bull. 20 [*Hadar* 9 (6—7)].

16) Reichert, I. and Perlberger, J. (1936). The Prevention of Diseases in Citrus Seed Beds *Rehovot Agr. Res. Sta.* Bull. 22 [*Hadar* 9 (11—12)].

TABLES

TABLE I.

FIELD EXPERIMENT

Sweet Lime Seedbed

Seeds from Fruit of Various Single Trees

Locality: Rehovot *Date of Last Count*: 19/2/1931

No. of Tree	Place of origin	Date of Sowing	No. of Seeds	Germination in 0/0 Total	Green	Albino	% Albinos among total number of seedlings
1	Gaza	3.12 1930	1430	85.4	54.6	30.8	37
2	Gaza	„	1810	73.2	64.0	9.2	12.5
3	Gaza	„	1216	85.4	72.9	12.5	14.7
4	Qubeiba	4.12 1930	1460	84.6	72.8	11.8	14
5	„	„	1100	63	56	7	11.1
6	Jericho I	„	540	74	66.4	7.6	10.2
7	„ I	„	650	83.5	73.8	9.7	11.6
8	„ I	„	710	88.1	74.7	13.3	15.2
9	„ II	„	1150	57.2	51.5	5.7	10.6
10	„ II	„	1020	74.1	60.8	13.3	18
11	Rehovot	1.1 1930	1970	78	65	13	16.6

TABLE II

FIELD EXPERIMENT

Sweet Lime Seedbed

Influence of size of Fruit and Seed

Nos. 1—6:

Date of Sowing: 22/11/29 *Date of Last Count*: 30/1/30

Nos. 7—12:

Date of Sowing: 25/11/29 *Date of Last Count*: 30/1/30

No. of Experiment	No. of Tree	Size of Fruits	Size of Seeds	No. of Seeds	Germination in %			% Albinos among total number of seedlings
					Total	Green	Albino	
1	A	Large	Large	684	73,0	52.1	20.9	28.7
2	A	„	Medium	356	53.6	35.0	18.6	43.4
3	A	„	Small	146	14.0	11.3	2.7	19.0
4	A	Small	Large	92	74,0	57.7	16.3	23.5
5	A	„	Medium	26	69.2	42.3	26.9	38.8
6	A	„	Small	16	50.0	25.0	25.0	50.0
7	B	Large	Large	455	74.0	57.8	16.2	21.6
8	B	„	Medium	433	57.0	47.6	9.4	16.6
9	B	Small	Small	137	25.4	20.3	5.1	20.0
10	B	„	Large	125	80.0	68.8	11.2	14.2
11	B	„	Medium	314	61.4	53.2	8.2	13.4
12	B	„	Small	95	24.2	19.0	5.2	21.7

TABLE IIa.

Nos. 13—24:

Date of Sowing: 22/1/29 *Date of Last Count*: 30/1/30

13	C	Large	Large	139	68.0	61.6	6.4	9.4
14	C	Large	Medium	391	72.0	68.7	3.3	4.5
15	C	Large	Small	110	35.0	31.4	3.6	10.2
16	C	Small	Large	76	85.0	78.5	6.5	7.6
17	C	Small	Medium	225	69.3	63.1	6.2	8.9
18	C	Small	Small	69	37.0			
19	D	Large	Large	164	80.0	70.3	9.7	12.2
20	D	Large	Medium	590	64.7	56.6	8.1	12.5
21	D	Large	Small	138	28.0	27.3	0.7	2.5
22	D	Small	Large	119	73.0	63.0	10.0	13.7
23	D	Small	Medium	333	57.0	47.4	9.6	16.9
24	D	Small	Small	123	12.0	9.6	2.4	20.0

TABLE IIb.

FIELD EXPERIMENT

Sweet Lime Seedbed

Influence of size of Fruit and Seed

Date of Sowing: 28/11/29 *Date of Last Count*: 30/1/30

No. of Experiment	No. of Tree	Size of Fruits	Size of Seeds	No. of Seeds	Germination in % Total	Green	Albino	% Albinos among total number of seedlings
25	E	Large	Large	173	56.0	41.6	14.4	25.7
26	E	Large	Medium	581	49.2	39.3	9.9	20.2
27	E	Large	Small	177	19.9	15.5	14.4	22.2
28	E	Small	Large	50	74.0	70.0	4.0	5.4
29	E	Small	Medium	232	51.7	44.1	7.6	15.0
30	E	Small	Small	104	29.5	20.9	8.6	29.0
31	F	Large	Large	93	70.0	57.1	12.9	18.1
32	F	Large	Medium	468	58.0	47.6	10.4	17.9
33	F	Large	Small	150	30.0	22.0	8.0	26.6
34	F	Small	Large	161	82.6	74.6	8.0	10.0
35	F	Small	Medium	297	62.0	58.7	3.3	4.8
36	F	Small	Small	75	24.0	22.7	1.3	5.5
37	G	Large	Large	137	62.8	53.4	9.4	15.1
38	G	Large	Medium	803	66.0	57.1	8.9	13.5
39	G	Large	Small	164	31.0	25.0	6.0	19.6
40	G	Small	Large	209	67.0	52.2	14.8	22.1
41	G	Small	Medium	294	57.8	50.4	7.4	12.9
42	G	Small	Small	137	30.0	17.6	12.4	41.4

TABLE IIc.

FIELD EXPERIMENT

Sweet Lime Seedbed

Influence of size of Fruit and Seed

Date of Sowing: 29/11/29 *Date of Last Count*: 30/1/30

No of. Exper-iment	No. of Tree	Size of Fruits	Size of Seeds	No. of Seeds	Germination in %			% Albinos among total number of seedlings
					Total	Green	Albino	
43	H	Large	Large	100	50.0	43.0	7.0	14.0
44	H	Large	Medium	526	54.9	50.0	4.9	8.9
45	H	Large	Small	140	25.7	22.9	2.8	11.4
46.	H	Small	Large	50	84.0	70.0	14.0	16.6
47	H	Small	Medium	236	59.0	45.1	13.9	23.5
48	H	Small	Small	50	28.0	26.0	2.0	7.1
49	J	Large	Large	210	63.8	56.2	7.6	12.9
50	J	Small	Medium	529	57.8	50.7	7.1	12.4
51	J	Small	Small	180	27.7	22.7	5.0	18.0
52	J	Small	Large	32	81.2	71.9	9.3	11.5
53	J	Small	Medium	116	61.0	57.6	3.4	5.6
54	J	Small	Small	100	19.0	16.0	3.0	15.7
55	K	Large	Large	134	35.8	32.1	3.7	10.3
56	K	Large	Medium	752	48.2	43.2	5.0	10.4
57	K	Large	Small	160	21.8	19.3	2.5	11.4
58	K	Small	Large	45	73.3	62.2	11.1	15.1
59	K	Small	Medium	167	50.3	45.6	4.7	9.4
60	K	Small	Small	68	26.4	22.0	4.4	16.6
61	x		Large	68	35.3	20.6	14.7	41.6
62	xx		Medium	176	31.8	11.3	20.5	64.2
63	xxx		Small	61	20.0	13.5	6.5	33.3

x, xx, xxx } The Fruit from Cyprus.

Date of Sowing: 10/12/29
Date of Last count: 30/1/30

TABLE III.

FIELD EXPERIMENT

Sweet Lime Seedbed

Treatment with Different Disinfectants

Locality: Bnei-Brak *Date of Sowing*: M/81—M/90: 21/11/30
M/91—M/94: 3/12/30
Date of Last Count: 15/2/31

No. of Nursery	Soil Disinfection	Treatment of Seeds	No. of Seeds	Germination in % Total	Green	Albino	% Albinos among total number of seedlings
M/81	Formalin 1 : 200	Uspulun ¼%	634	63	63	0	0
M/82	„	Uspulun ⅛%	525	82	82	0	0
M/83	„	Germisan ¼%	533	77	77	0	0
M/84	„	Germisan ⅛%	560	74	74	0	0
M/85	„	Abavit	544	52	52	0	0
M/86	„	–	582	97	60	37	39
M/87	–	Germisan ⅛%	293	77	77	0	0
M/88	–	Uspulun ⅛%	338	62	62	0	0
M/89	–	Abavit	352	45	45	0	0
M/90	–	–	1022	29	12	17	74
M/91	Germisan ¼%	–	386	35	33	2	4
M/92	Germisan ⅛%	–	409	14	12	2	12
M/93	Uspulun ¼%	–	381	23	14	9	40
M/94	Uspulun ⅛%	–	363	30	16	14	47

TABLE IV.
FIELD EXPERIMENT
Sour Orange Seedbed
Treatment with Different Disinfectants
Locality: Bnei-Brak
Date of Sowing: 23/12/30 *Date of Last Count*: 20/2/31

No of Seedbed	Soil Dis-infection	Treat-ment of Seeds	No. of Seeds	Germination in %			% Albinos among total number of seedlings
				Total	Green	Albino	
M/95	Formalin 1 : 200	Uspulun ¼%	387	85	85	0	0
M/96	„	Uspulun ⅛%	402	67	66	1	2
M/97	„	Germisan ¼%	403	65	60	5	9
M/98	„	Germisan ⅛%	397	78	73	5	6
M/99	„	Abavit	403	62	62	0	0
M/100	„	--	400	82	75	7	9
M/101	–	Uspulun ⅛%	365	96	96	0	0
M/102	–	Germisan ⅛%	355	88	88	0	0
M/103	–	Abavit	380	87	87	0	0
M/104	–	–	1057	79	70	9	12
M/105	Uspulun ¼%	–	512	84	77	7	8
M/106	Uspulun ⅛%	–	537	91	81	11	12
M/107	Germisan ¼%	–	515	87	84	3	3
M/108	Germisan ⅛%	–	522	74	72	2	2

TABLE IVa.

Field Experiment

Sweet Lime Seedbed

Treatment with Different Disinfectants

Locality: Rehovot

Nos. 1—5, 8—14:
Date of Sowing: 12/3/34 *Date of Last Count*: 16/5/34
Nos. 6—7:
Date of Sowing: 3/5/34 *Date of Last Count*: 25/6/34

No. of Seedbed	Soil Disinfection	Treatment of Seeds	No. of Seeds	Germination in % Total	Green	Albino	% Albinos among total number of seedlings
1	Uspulun 1/8%	—	192	89.5	84.0	5.5	6
2	Uspulun 1/16%	—	192	98.5	98.0	0.5	0.5
3	Uspulun 1/32%	—	192	114.5	114.0	0.5	0.5
4	Uspulun 1/64%	—	192	104.5	102.0	2.5	2.5
5	—	—	192	114.0	112.0	2.0	2.0
6	Ceresan 1/8%	—	200	35	35	0	0
7	Ceresan 1/16%	—	200	55	55	0	0
8	Ceresan 1/32%	—	200	56	56	0	0
9	Ceresan 1/64%	—	200	70	68.5	1.5	2
10	—	—	200	76.5	76.5	0	0
11	—	Ceresan 1/4%	100	60	60	0	0
12	—	Ceresan 1/8%	100	92	92	0	0
13	—	Ceresan 1/16%	100	96	96	0	0
14	—	Ceresan 1/32%	100	90	90	0	0

TABLE IVb.

Sour Orange Seedbed

Locality: Rehovot *Date of Sowing*: 12/3/34
Date of Last Count: 16/5/34

1	Uspulun 1/8%	—	200	45.5	45.5	0	0
2	Uspulun 1/16%	—	200	52.5	52.5	0	0
3	Uspulun 1/32%	—	200	69.5	69.5	0	0
4	Ceresan 1/64%	—	200	75	73	2	3
5	—	—	200	72.5	72.5	0	0

TABLE V.

FIELD EXPERIMENT

Sweet Lime Seedbed

Soil Disinfection at Different Times; Soil: Sandy Loam

Locality: Rehovot

Date of Sowing: 30/1/35 *Date of Last Count*: 14/3/35

No. of Seed-bed	Soil disin-fection	Time of Disin-fection	Treat-ment of Seeds	No. of Seeds	Germination in % Total	Green	Albino	% Albinos among to-tal number of seedlings
1	Ceresan 1 : 1000	14 days be-fore sowing	–	500	40	39.5	0.5	2
2	Ceresan 1: 2000	"	–	500	53	52	1	2
3	Ceresan 1 : 3000	"	–	500	47	46	1	2
4	Ceresan 1 : 4000	"	–	500	37.5	36.5	1	2
5	Ceresan 1 : 1000	On the day of sowing	–	450	65	63	2	3
6	Ceresan 1 : 3000	"	–	450	64	61	3	4
7	Ceresan 1 : 1000	On day after sowing	–	450	42	41	1	3
8	Ceresan 1 : 3000	"	–	450	30	28.5	1.5	5
9	–	–	Ceresan 1 : 1000	500	50	49	1	2
10	–	–	Ceresan 1 : 2000	500	76	75.5	0.5	0.5
11	–	–	Ceresan 1 : 3000	500	74	73.5	0.5	0.5

TABLE VI.

FIELD EXPERIMENT

Sweet Lime Seedbed

Seeds from Fruit Stored for 4 months

Locality: Tel-Aviv *Date of Sowing*: 20/4/31

Date of Last Count: 3/7/31

No. of Seedbed	Soil Disin-fection	Treatment of Seeds	No. of Seeds	Germination in % Total	Green	Albino	% Albinos among to-tal number of seedlings
P/1	—	—	175	57	35	22	38
P/2	—	Germisan 1/8%	85	80	79	1	1
P/3	—	Germisan 1/16%	174	76	73	3	4
P/4	—	Uspulun 1/8%	84	36	32	4	10

TABLE VII.

FIELD EXPERIMENT

Sweet Lime Seedbed

Treatment of soil and seeds; origin of seeds (1) *Nes Tsiyona and* (2) *Ramleh*

Locality: Nes Tsiyona

Date of Sowing: 14/12/34 *Date of Last Count*: 26/4/35

No. of Seed-bed	Soil Disin-fection	Treat-ment of seeds	No. of Seeds	Germination in %			% Albinos among total number of seedlings	Origin of Fruit.
				Total	Green	Albino		
1	Formalin	–	1400	66.8	28.7	38.1	57.0	Ramleh
1a	1/100	–	1600	65.3	40.9	24.4	37.3	Nes-Tsiyona
2	,,	Ceresan	1400	73.3	72.6	0.7	0.9	Ramleh
2a	,,	1/1000	1600	48.1	45.0	3.1	12.6	Nes-Tsiyona
3	,,	Ceresan	1600	69.6	68.5	1.1	1.7	Ramleh
3a	,,	1/2000	1400	54.4	49.4	5.0	9.1	Nes-Tsiyona
4	Formalin	–	1600	60.6	22.8	37.8	54.6	Ramleh
4a	1/200	–	1400	63.8	38.1	25.7	40.3	Nes-Tsiyona
5	,,	Ceresan	1400	54.4	53.6	0.8	1.5	Ramleh
5a	,,	1/2000	1600	44.3	43.6	0.7	1.6	Nes-Tsiyona
6	,,	Ceresan	1400	40.3	39.5	0.8	2.0	Ramleh
6a	,,	1/1000	1600	53.6	52.5	1.1	2.0	Nes-Tsiyona
7	–	–	1600	60.9	28.4	32.5	53.4	Ramleh
7a	–	–	1400	70.0	50.0	20.0	28.6	Nes-Tsiyona
8	Ceresan	–	1600	86.3	38.6	47.7	55.4	Ramleh
8a	1/5000	–	1400	72.0	44.0	28.0	38.8	Nes-Tsiyona
9	,,	Ceresan	1400	27.1	27.1	0	0	Ramleh
9a	,,	1/1000	1600	63.5	60.0	3.5	5.5	Nes-Tsiyona
10	,,	Ceresan	2400	50.0	49.1	0.9	1.8	Ramleh
10a	,,	1/2000	600	65.8	63.3	2.5	3.7	Nes-Tsiyona
11	–	–	1600	65.6	24.4	41.2	62.8	Ramleh
11a	–	–	1400	80.0	53.9	27.1	33.9	Nes-Tsiyona

TABLE VIII.

FIELD EXPERIMENT

Sweet Lime Seedbed

Treatment of Seeds and Soil

Locality: Yibna

Date of Sowing: 25/1/35 *Date of Last Count*: 9/4/35

No. of Seed-bed	Soil Disin-fection	Treat-ment of Seeds	No. of Seeds	Germination in %			% Albinos among to-tal number of seedlings
				Total	Green	Albino	
1*	–	–	10.000	29	10	19	68.8
2	–	–	2.000	55.8	39.5	16.5	29.6
3	Formalin 1/100	–	2.000	45.1	25.8	19.3	42.9
4	,,	Ceresan 1/1000	2.000	68.4	67.5	0.9	1.3
5	Formalin 1/200	,,	2.000	67.8	67.3	0.5	0.8
6	,,	,,	2.000	62.7	62.7	0	0

*) Seedbed No. 1: Soil heated due to fresh manure.

TABLE IX.

Locality: Rehovot

Date of Sowing: 20/12/34 *Date of Last Count*: 25/4/35

63*)	Ceresan 1 : 4000	Ceresan 1 : 2000	1500	47.3	46.3	1	2.1
63a	,,	–	1500	46.0	33.6	12	26.9
64	,,	Ceresan 1 : 1000	1500	23	22.5	0.5	2.2
64a	,,	–	1500	14.5	10.9	3.6	25.1
65	Formalin 1 : 200	Ceresan 1 : 2000	1500	36.6	36.1	0.5	1.6
65a	,,	Ceresan 1 : 1000	1500	27.3	26.3	1.0	3.6
66	,,	Uspulun 1 : 1000	1500	43.3	42.3	1.0	2.3
66a	,,	–	1500	31.0	23.1	7.9	25.7

*) Seedbed No. 63: origin of seeds: Jericho.

TABLE X.

Laboratory Experiment

Sweet Lime Germination Tins

Seeds Sown in Pure Autoclaved Sand after their treatment with Different Solutions

Nos. 1—10;
Date of Sowing: 25/2/34 *Date of Last Count*: 15/4/34
Nos. 11—20;
Date of Sowing: 30/4/34 *Date of Last Count*: 20/6/34
Nos. 21—23;
Date of Sowing: 25/5/34 *Date of Last Count*: 18/7/34

No.	Treatment of Seeds	No. of Seeds	Germination in %			% Albinos among total number of seedlings
			Total	Green	Albino	
1	Uspulun ¼%	50	92	92	0	0
2	Uspulun ⅛%	50	124	116**	8	6.4
3	Uspulun 1/16%	50	112	108	4	3.8
4	Uspulun 1/32%	50	106	78	28	26.4
5	Aq. Dest.	50	96	32	64	66.6
6*	Uspulun ¼%	50	112	112	0	0
7	Uspulun ⅛%	50	112	112	0	0
8	Uspulun 1/16%	50	110	110	0	0
9	Uspulun 1/32%	50	92	89	3	3.2
10	Aq. Dest.	50	100	98	2	2
11	Ceresan ¼%	100	88	88	0	0
12	Ceresan ⅛%	100	90	90	0	0
13	Ceresan 1/16%	100	94	93	1	1
14	Ceresan 1/32%	100	98	98	0	0
15	Uspulun ⅛%	100	97	97	0	0
16	Uspulun 1/16%	100	100	100	0	0
17	Aq. Fontis	100	97	74	23	24
18	,,	100	91	73	18	20
19	Aq. Dest.	100	100	78	22	22
20	,,	100	100	87	13	13
21	Uspulun ⅛%	100	84	82	2	2
22	Ceresan ¼%	100	93	93	0	0
23	Aq. Dest.	100	63	48	15	24

*) Nos. 6—10, 16—20, Seeds not covered.

**) Germination greater than 100% occurred as the seeds sometimes have more than one embryo.

TABLE XI.

LABORATORY EXPERIMENT

Sour Orange Germination Tins

Seeds Sown in Pure Autoclaved Sand after their Treatment with Different Solutions

Nos. 1—10;

Date of Sowing: 26/2/34 *Date of Last Count*: 17/4/34

Nos. 11—20;

Date of Sowing: 11/4/34 *Date of Last Count*: 30/5/34

No.	Treatment of Seeds	No. of Seeds	Germination in %			% Albinos among total number of seedlings
			Total	Green	Albino	
1	Uspulun ¼%	100	101	101	0	0
2	Uspulun ⅛%	100	93	93	0	0
3	Uspulun $^1/_{16}$%	100	106	106	0	0
4	Uspulun $^1/_{32}$%	100	101	101	0	0
5	Aq. dest.	100	108	80	28	25.9
6*	Uspulun ¼%	100	96	96	0	0
7	Uspulun ⅛%	100	94	93	1	1
8	Uspulun $^1/_{16}$%	100	101	101	0	0
9	Uspulun $^1/_{32}$%	100	100	100	0	0
10	Aq. Dest.	100	98	72	26	26.5
11	Uspulun ¼%	50	102	102	0	0
12	Uspulun ⅛%	50	84	84	0	0
13	Uspulun $^1/_{16}$%	50	86	86	0	0
14	Uspulun $^1/_{32}$%	50	64	62	2	2
15	Aq. Dest.	50	112	108	4	4
16**	Uspulun ¼%	50	106	106	0	0
17	Uspulun ⅛%	50	102	102	0	0
18	Uspulun $^1/_{16}$%	50	92	92	0	0
19	Uspulun $^1/_{32}$%	50	104	104	0	0
20	Aq. Dest.	50	98	80	18	20

*) Nos. 6—10 Seeds not covered.

**) Nos. 16—20 Seeds not covered.

TABLE XII.

LABORATORY EXPERIMENT

Sweet Lime Germination Tins

Seeds Sown in Different Soils

Nos. 42—49;

Date of Sowing: 26/7/34 *Date of Last Count*: 12/9/34

Nos. 50—58;

Date of Sowing: 11/1/35 *Date of Last Count*: 29/3/35

No.	Type of soil	No. of Seeds	Germination in % Total	Germination in % Green	Germination in % Albino	% Albinos among total number of seedlings	Remarks
42	Sand-Kurkar 1	100	45	35	9	20	
43	" 2	100	30	26	4	13	
44	Sand-clay soil 1	100	23	13	8	35	The seeds
45	" " 2	100	21	18	3	14	were kept
46	Heavy-lime soil 1	100	61	53	8	13	dry from
47	" " 2	100	57	47	10	18	the end
48	Pure-autocl. sand 1	100	39	36	3	8	of April
49	" " 2	100	29	28	1	3	
50	Sand-Kurkar 1	100	67	48	19	28	dry
51	" 2	100	58	42	16	28	Aq. dest.
52	Sand-clay soil 1	100	68	48	20	37	dry
53	" " 2	100	35	25	10	29	Aq. dest.
54	Heavy-lime soil 1	100	58	42	16	28	
55	" " 2	100	43	32	11	26	
56	Heavy soil short of lime 1	100	61	31	30	49	
57	" " 2	100	61	41	20	33	
58	Pure-autocl. sand	100	76	53	23	30	

TABLE XIII.

Laboratory Experiment

Sweet Lime Germination Tins

a) *Seeds Sown in Pure Autoclaved Sand of Different Degrees of Moisture*

Date of Sowing: 9/1/35 *Date of Last Count*: 29/3/35

No.	Quantity of water per 1kg sand	No. of Seeds	Germination in %			% Albinos among total number of seedlings
			Total	Green	Albino	
59	50 gr.	100	82	46	36	44
60	100 gr.	100	76	53	23	30
61	200 gr.	100	51	41	10	20
62	250 gr.	100	0	0	0	0

b) *Seeds Sown in Pure Autoclaved Sand and Covered by Sand Layers of Different Thickness.*

No. of Seed: 100

No.	Treatment of Seeds	Height of Covering	Germination in %			% Albinos among total number of seedlings
			Total	Green	Albino	
63	Ceresan 1:1000	½ cm.	101	100	1	1
64	–	½ cm.	92	81	11	11
65	Ceresan 1:1000	1½ cm.	92	91	1	1
66	–	1½ cm.	104	78	26	25
67	Ceresan 1:1000	3 cm.	96	95	1	1
68	–	3 cm.	73	57	16	21.9
69	Ceresan 1:1000	5 cm.	90	90	0	0
70	–	5 cm.	65	46	19	29.2

TABLE XIV.

LABORATORY EXPERIMENT

Sweet Lime in Pots

Seeds Sown in Soil Rich in Humus, in Pots Covered by Bell Jars

Locality: Rehovot *Date of Sowing*: 25—27/12/34

Temperature: 20—24°C. *Date of Last Count*: 6/3/35

No. of pot	Treatment of Seeds	Number of Seeds	Germination in %			% Albinos among total number of seedlings
			Total	Green	Albino	
1	2	3	4	5	6	7
1	—	50	80	76	4	5
2	—	50	80	72	8	10
3	—	50	110	88	22	20
4	—	50	110	88	22	20
5	—	50	100	36	64	64
6	—	50	76	20	56	74
7	—	50	80	40	40	50
8	—	50	96	76	18	19
9	—	50	88	48	40	45
10	—	50	86	36	50	58
11	—	50	82	66	16	20
12	—	50	76	42	34	45
13	—	50	70	20	50	71
14	—	50	112	78	34	30
15	—	50	78	48	30	38
16	—	50	80	20	60	75
17	—	50	72	64	8	11
18	—	50	78	26	52	67
19	—	50	100	44	56	56
20	—	50	100	78	22	22
	—	1000	87.6	53.3	34.3	39.1

TABLE No. XV.

FIELD EXPERIMENT

Sweet Lime in Pots I

Seeds Sown in Autoclaved Soil Rich in Humus

Locality: *Rehovot*

Date of Last Count: 6/3/35 *Date of Sowing*: 25—27/22/34

1	—	100	81	71	10	12
2	—	100	90	88	2	2
3	—	100	76	72	4	5
4	—	100	78	77	1	1
5	—	100	79	74	5	6
6	—	100	73	60	13	18

TABLE XV (continued)

1	2	3	4	5	6	7
7	—	100	90	83	7	9
8	—	100	88	69	19	22
9	—	100	60	58	2	3
10	—	100	73	57	16	22
11	—	100	74	37	37	50
12	—	100	60	14	46	77
13	—	100	70	47	23	33
14	—	100	64	25	39	61
15	—	100	65	43	22	34
16	—	100	84	76	8	10
17	—	100	55	32	23	42
18	—	100	60	43	17	28
19	—	100	85	40	45	53
20	—	100	68	42	26	38
		2000	73.8	55.4	18.4	24.9

TABLE XVI.

FIELD EXPERIMENT

Sweet Lime in Pots II

Seeds Sown in Autoclaved Soil Rich in Humus

Locality: Rehovot

Date of Sowing: 25—27/12/34 *Date of Last Count*: 6/3/35

1	—	100	90	81	9	10
2	—	100	65	63	2	3
3	—	100	60	58	2	3
4	—	100	94	94	0	0
5	—	100	85	75	10	12
6	—	100	90	81	9	10
7	—	100	85	79	6	7
8	—	100	89	79	10	11
9	—	100	91	89	2	2
10	—	100	81	73	8	10
11	—	100	70	50	20	29
12	—	100	87	85	2	2
13	—	100	85	80	5	6
14	—	100	86	83	3	3
15	—	100	78	71	7	9
16	—	100	83	70	13	16
17	—	100	80	53	27	34
18	—	100	87	76	11	13
19	—	100	75	59	16	21
20	—	100	79	73	6	7
		2000	82.5	73.6	8.9	10.7

TABLE XVII.

LABORATORY EXPERIMENT

Sweet Lime Germination Tins

Seeds Extracted and Sown at Different Times

No.	Date of Picking	Date of Extracting	Treat. of seeds	Date of Treatment	Date of Sowing	Date of last count	Germination in % Total	Germination in % Green	Germination in % Albino	% Albinos among total number of seedlings
		1935								
81	20/12	3/2	Aq. Dest.	3/2	4/2	5/4	90	83	7	8
82	"	"	—	—	"	"	83	67	16	19
95	"	2/4	Aq. Dest.	2/4	3/4	30/5	95	85	10	11
96	"	"	—	—	"	"	94	86	8	9
		1934			1935					
72	"	30/12	Aq. Dest.	31/12	1/1	8/3	96	88	8	8
73	"	"	—	"	"	"	103	92	11	11
				1935						
78	"	"	Aq. Dest.	31/1	1/2	5/4	30	26	4	13
79	"	"	—	—	"	"	25	18	7	28
86	"	"	Aq. Dest.	5/3	6/3	23/4	0	0	0	0
87	"	"	—	—	"	"	2	2	0	0
92	"	"	Aq. Dest.	3/4	4/4	30/5	2	2	0	0
93	"	"	—	—	"	"	1	1	0	0

TABLE XVIII.

LABORATORY EXPERIMENT

Sweet Lime Germination Tins

Seeds from each Fruit Sown Separately in Autoclaved Sand

Date of Sowing: 12/12/35 *Date of Last Count*: 3/2/36

No. of Seed bed	No. of Seeds in each fruit	Germination in % Total	Germination in % Green	Germination in % Albino	% Albinos among total number of seedlings
1	2	3	4	5	6
1	3	70	70	0	0
2	8	137	100	37	27
3	5	40	40	0	0
4	4	50	50	0	0
5	7	28	28	0	0
6	5	100	100	0	0
7	5	80	80	0	0
8	8	112	100	12	11

TABLE XVIII (continued)

1	2	3	4	5	6
9	7	85	71	14	16
10	4	100	50	50	50
11	4	75	50	25	30
12	4	75	25	50	66
13	7	142	100	42	30
14	6	50	17	33	66
15	8	87	37	50	57
16	4	25	0	25	100
17	7	114	85	28	25
18	5	80	40	40	50
19	7	85	57	28	33
20	7	85	42	42	50
21	5	100	40	60	60
22	6	100	50	50	50
23	5	20	20	0	0
24	6	83	50	33	40
25	11	54	27	27	50
26	6	83	50	33	40
27	6	33	16	16	50
28	5	80	20	60	75
29	5	120	40	80	66
30	4	75	50	25	33
31	7	70	28	42	60
32	14	70	35	35	50
33	8	62	37	25	40
34	8	125	62	62	50
35	10	100	60	40	40
36	14	64	50	14	22
37	7	42	28	14	33
38	5	100	80	20	20
39	10	80	60	20	25
40	7	57	57	0	0
41	5	120	80	40	33
42	5	80	60	20	25
43	5	140	80	60	42
44	7	28	14	14	50
45	8	112	75	37	33
46	5	60	60	0	0
47	6	100	33	66	66
48	10	50	40	10	20
49	10	100	77	22	22
50	10	80	0	80	100

TABLE XIX.

LABORATORY EXPERIMENT

Sweet Lime Germination Tins

Seeds Sown in Pure Autoclaved Sand after Treatment with Different Salt Solutions

Nos. 21—23;

Date of Sowing: 25/5/34 *Date of Last Count*: 18/7/34

Nos. 24—34;

Date of Sowing: 2/5/34 *Date of Last Count*: 15/7/34

No.	Treatment of Seeds	No. of Seeds	Germination in %			% Albinos among total number of seedings
			Total	Green	Albino	
21	Uspulun ⅛%	100	84	82	2	2
22	Ceresan ⅛%	100	93	93	0	0
23	Aq. Dest.	100	63	48	15	24
24	$MgSO_4$ 1:500	100	91	53	38	42
25	$MgSO_4$ 1:1000	100	87	39	48	55
26	$MgSO_4$ 1:2000	100	67	25	42	63
27	$FeSO_4$ 1:500	100	80	46	34	43
28	$FeSO_4$ 1:1000	100	84	28	56	66
29	$CuSO_4$ 1:500	100	88	87	1	1
30	$CuSO_4$ 1:1000	100	86	83	3	3
31	$ZnSO_4$ 1:500	100	77	45	32	42
32	$ZnSO_4$ 1:1000	100	92	59	33	36
33	$HgCl_2$ 1:1000	100	48	47	1	2
34	$HgCl_2$ 1:2000	100	95	89	6	7

*) Fruits picked in the middle of May. Nos. 21—23.

TABLE XX.

Date of Sowing: 26/7/34 *Date of Last Count*: 12/9/34

35	Hg Cl_2 1:2000	100	28	28	0	0
36	Hg Cl_2 1:4000	100	46	46	0	0
37	Cu SO_4 1:500	100	75	75	0	0
38	Ceresan ⅛%	100	70	70	0	0
39	Ceresan 1/16%	100	62	62	0	0
40	Aq. dest.	100	39	36	3	8
41	Aq. dest.	100	29	28	1	3

*) The seeds in experiments 35—38 were removed from the fruit at the end of April, and kept dry till time of sowing.

TABLE XXI.

Sweet Lime Germination Tins

Seeds Sown after Treatment with Different Salt Solutions

No.	Date of Sowing	Date of last Count	Treatment of Seeds	Germination in % Total	Green	Albino	% Albinos among total number of seedlings
1	2	3	4	5	6	7	8
	1935	1935					
97	4.1	14.3	$MgCl_2$ 1/100N	94	88	6	6
98	„	„	$MgCl_2$ 1/200N	59	53	6	12
99	„	„	$MgCl_2$ 1/400N	95	85	10	11
100	„	„	$CaCl_2$ 1/100N	75	55	20	27
101	„	„	$CaCl_2$ 1/200N	74	62	12	16
102	„	„	$CaCl_2$ 1/400N	86	72	14	16
103	„	„	$SrCl_2$ 1/100N	93	74	19	20
104	„	„	$SrCl_2$ 1/200N	90	78	12	13
105	„	„	$SrCl_2$ 1/400N	89	75	14	16
106	„	„	$BaCl_2$ 1/100N	95	76	19	20
107	„	„	$BaCl_2$ 1/200N	90	74	16	18
108	„	„	$BaCl_2$ 1/400N	103	90	13	13
109	„	„	$MnCl_2$ 1/100N	93	82	11	12
110	„	„	$MnCl_2$ 1/200N	95	84	11	12
111	„	„	$MnCl_2$ 1/400N	91	84	7	8
112	13.2	19.4	$FeSo_4$ 1/100N	79	63	16	20

TABLE XXI (continued)

1	2	3	4	5	6	7	8
113	8.4	12.7	$Co(NO_3)_2$ 1/100N	50	49	1	2
114	,,	,,	$Co(NO_3)_2$ 1/200N	53	53	0	0
115	,,	,,	$Co(NO_3)_2$ 1/400N	58	58	0	0
116	,,	,,	$NiCl_2$ 1/100N	55	55	0	0
117	,,	,,	$NiCl_2$ 1/200N	70	70	0	0
118	,,	,,	$NiCl_2$ 1/400N	65	57	8	12

TABLE XXII.

LABORATORY EXPERIMENT

Sweet Lime Germination Tins

Seeds Sown after Treatment ith Different Salt Solutions

No.	Date of Sowing	Date of last count	Treatment of Seeds	Germination in %			% Albinos among total number of seedlings
				Total	Green	Albino	
1	2	3	4	5	6	7	8
	1935	1935					
119	4.1	14.3	$CuCl_2$ 1/100N	97	97	0	0
120	,,	,,	$CuCl_2$ 1/200N	95	95	0	0
121	,,	,,	$CuCl_2$ 1/400N	87	86	1	1
122	13.2	19.4	$ZnSO_4$ 1/100N	98	56	42	43
123	,,	,,	$ZnSO_4$ 1/200N	66	46	20	38
124	,,	,,	$ZnSO_4$ 1/400N	80	50	30	38
125	4.1	14.3	$HgCl_2$ 1/100N	16	16	0	0
126	,,	,,	$HgCl_2$ 1/200N	19	19	0	0
127	,,	,,	$HgCl_2$ 1/400N	56	56	0	0

TABLE XXII (continued)

1	2	3	4	5	6	7	8
128	8.5	12.7	$HgCl_2$ 1/200N	30	30	0	0
129	,,	,,	$HgCl_2$ 1/400N	57	57	0	0
130	,,	,,	$HgCl_2$ 1/800N	67	67	0	0
131	,,	,,	$PbCl_2$ 1/100N	70	68	2	3
132	,,	,,	$PbCl_2$ 1/200N	43	40	3	7
133	,,	,,	$PbCl_2$ 1/400N	52	48	5	10
134	,,	,,	Ceresan 1/200N	70	67	3	4
135	,,	,,	Aq. dest.	44	34	10	25
136	1.1	8.3	Ceresan 1/500	91	91	0	0
137	,,	,,	Ceresan 1/100N	101	100	1	1
138	,,	,,	Ceresan 1/200N	102	101	1	1
139	,,	,,	Ceresan 1/400N	93	93	0	0
140	,,	,,	Aq. dest.	96	88	8	8
141	,,	,,	—	103	92	11	11

TABLE XXIII.

Laboratory Experiment

Sweet Lime Germination Tins

Seeds Sown after Treatment with Sap taken from Albinistic Seedlings

Date of Sowing: 19/3/38 *Date of Last Count*: 8/5/38

No. of Seed-bed	Treatment	No. of seeds	Germination in % Total	Green	Albino	% Albinos among total number of seedlings
1	Treated with sap of albino seedlings for 1 hour	100	66	64	2.0	3.0
2		100	56	55	1.0	
3	Treated with sterilized water	100	69	68	1.0	
4		100	72	70	2.0	3.0

CONTENTS:

DOTHIORELLA ROT OF BANANAS AND ORANGES IN PALESTINE *)

By I. REICHERT and ESTHER HELLINGER

Division of Plant Pathology, J. A. P. Agr. Res. Sta., Rehovot.

INTRODUCTION

A previously unrecorded banana fruit rot of some economic importance was first found in Palestine in banana plantations in the surroundings of Jaffa—Tel-Aviv towards the end of 1929. The disease makes its appearance in the grove during late autumn, and from observations in the grove appears to be at its optimum growth during the winter. As the warmer weather approaches the disease drops off and is of slight occurrence during the summer.

The fungus responsible for this rot is a *Dothiorella sp.*, the taxonomic position of which will be discussed later.

Description of the disease

The disease is a typical tip-end rot (Pl. VIII, fig. 1). Invariably it commences at the floral end as a blackish discoloured rot, and progresses slowly towards the proximal or stem-end of the fruit. The blackening of the rotted part is preceeded by a varying, though generally narrow, brown watery margin forming a distinct line of demarcation between sound and affected tissue. Numerous minute black fruiting bodies, the pycnidia, are to be seen at the surface of the rot, having burst through the epidermis. When the pycnidium is ripe and the spores forcibly ejected together, they give the appearance of a fine particle of white powder from each pycnidium. This fine white powdery effect thus produced is characteristic of the macroscopic features of

* This work is a contribution to the "Investigation of Fruit Rots of Palestine" carried out during the period 1929—31, by the support of the Empire Marketing Board, London.

the disease. A slight amount of fine greyish white mycelial threads may be found at the floral end of the rot.

An interior examination of the rotted fruit reveals that the rot advances along the peel far more rapidly than through the fleshy pulp of the fruit. The affected pulp turns black in colour.

The causal organism

Repeated cultures of the affected tissue of the fruit on different culture media to isolate the responsible organism of the rot gave pure cultures of a sterile mycelial growth, at first greyish-white, later becoming fumaceous in colour. No fruiting bodies, like those found on the fruit under natural conditions, were produced in culture. On sterilized potato wedges the fungus produced a dense white cottony mycelial growth, which after several days turned greyish-black to black, forming eventually a black crust over the potato tissue.

Bananas inoculated with sterile mycelium on potato agar and placed in moist chambers, developed a rot and typical pycnidia were produced at the surface. Under moist conditions, however, the dark brown rotted tissue was covered with smoky grey mycelium preceeded by a watery brown margin. Isolations of the organism from the artificially inoculated fruits gave also only sterile mycelium on agar media. Apparently it fructifies only under certain conditions. The inoculation experiments thus clearly proved the parasitism of the fungus.

Microscopic details of the fungus as it appears under natural conditions on the banana fruit show that the pycnidium is thick walled and more or less globose with an ostiolate papilla. The outer part of the pycnidial wall is composed of black, thick walled cells, while the inner lining is made up of several rows of thin walled polygonous cells. The pycnidium is generally produced in the superficial layers of the peel, and as it develops, it breaks through the surface. Under such conditions the pycnidia may occur singly or sometimes several may be associated together, but with very little stromatic tissue. The pycnidia measure from about 141 to 323 microns in length and from 141 to 242 microns in width. They contain the ovoid or fusoid pycnospores which measure from 13 to 21 microns in length by 4 to 7 microns in width, the average size of the spores being 16 by 5.

microns. The spores are thin walled and hyaline, with granulated contents (Pl. VII, fig. 2).

From its morphological details it is evident that the fungus is a *Dothiorella*, although as yet no perfect stage has been found.

Conditions of infection

Wind and insects serve to spread the disease by disseminating the minute spores. Insects are attracted by an exudation of a sticky fluid formed under certain conditions at the base of the floral leaves, while the fruit is still very young and small. One has also to assume that the sterile flowers beneath the fruits may harbour the fungus for often they are to be seen contaminated with mycelial growth.

The disease is of importance during the winter when the humid conditions appear to be most favourable for its development. It may, however, occur at higher temperatures, as it has been found in the grove towards the end of July, although to a much slighter extent. Inoculation experiments carried out early in June at higher temperatures (25—27°) also gave positive results.

Relation of Dothiorella sp. on banana to Dothiorella sp. on citrus fruits

Towards the end of the 1930/31 orange season a black rot of oranges was met with, hardly distinguishable from *Diplodia* stem-end rot. (18). In culturing the diseased fruits to isolate the responsible organism, a fluffy greyish white mycelial growth was produced which, with age, turned grey, then fumaceous in colour, and scattered pycnidia were formed containing spores closely resembling in all features those of *Dothiorella* on banana. Further platings of the organism on potato dextrose agar produced several comparatively large, black, raised, hard masses up to several millimetres in width. Microscopic examinations of these stromatic masses showed a number of sporocarps embedded in the stroma. The sporocarps measured 435 to 500 microns by 340 to 450 microns and were chiefly filled with parenchymatous tissue. Within some of them a few asci were found, each containing eight ascospores. On the whole there was a very slight production of ascospores. The ascopores measured from 14.5 to 19 by 5.0 to 8.5 microns. The average size was 15×6.8 microns. Reculturing the fungus produced only the perfect or perithecial stage. The fungus produced a dense white cottony growth on sterilized

potato wedges, which after some days began to turn black. Within a week black fruiting bodies were produced composed of several or more sporocarps embedded in a stroma.

Cross inoculation experiments were carried out with the banana and orange *Dothiorellas* on bananas and citrus fruits. The banana form inoculated on green oranges developed a black rot which from its macroscopic features was indistinguishable from *Diplodia* stem-end rot, but typical pycnidia of the *Dothiorella* type were produced on the fruits. The orange *Dothiorella* on banana, in moist chambers produced a rot indistinguishable from that on the bananas inoculated with the banana fungus. Typical pycnospores of the *Dothiorella* type were produced on the fruit. These spores measured 12—20 microns by 3.5—6 microns; the average being 16×5 microns.

Control.

To check the banana disease and keep it under control the following measures are advised:

1. Periodic inspection of the grove for diseased fruits.

2. All infected fruits should be carefully cut off from the bunch., or at least at their tips, and immediately removed in a receptacle and buried in a deep pit or burned at a distance from the grove.

3. The withered sterile flowers should be removed from the bunches and taken away in a receptacle.

4. A free circulation of air is necessary for the healthy development of the fruit.

5. Spray with ammoniacal copper carbonate mixture, which gives good results in this country.

Discussion

The above described fungus, causing rots of banana and citrus closely resembles a *Dothiorella* fungus, described by a number of authors as attacking fruit, leaves or branches of certain fruit trees in various countries particularly those having a warm and humid climate.

Reviewing the literature on organisms which to day are considered as *Dothiorellas*, we may say that no *Dothiorella* disease resembling our fungus has been described on the banana. *Macrophoma ensetes* described by Saccardo and Scalia (21) on banana in 1902, with its spore measurement 18—21 microns by 6 microns seems to

resemble our fungus. It, however, was proved to be a *Colletotrichum* by PETRAK and SYDOW (15), and therefore not identical with our organism. Our finding of the *Dothiorella* rot of banana in Palestine in 1929 is, therefore the first record of such a disease. (17,28). In 1937 ROGER and MALLAMAIRE (19) published a report of a *Dothiorella* rot of banana fruit from West Africa (French Guinea and Ivory Coast). They call this fungus *Macrophoma ensetes* Sacc. and give as the dimensions of its spores 15—23 microns by 4—6 microns, which resemble ours. As mentioned above, this name is no longer valid.

The first mention of a *Dothiorella*-like fungus on citrus was made by PENZIG (12) in 1884, in his description of *Phoma Montegaziana,* found on citrus leaves in Italy. A drawing of spores and pycnidia accompanies his description. The size of his spores, 16—20 microns by 5—7 microns approaches that of the spores of our *Dothiorella*. PENZIG's fungus shows no sign of stroma. PETRAK and SYDOW (15) and ARNAUD (2) include non-stromatic forms in the genus *Dothiorella* and emphasizes the fact that stromatic forms, when they occur on leaves, often lose their stroma. Accordingly. PENZIG's *Phoma* may be considered a *Dothiorella.*

Another *Dothiorella* species was found by CELATTI in 1892 on citrus branches in Southern France. CELATTI called this species *Macrophoma citri.* According to SACCARDO (20), the pycnospores of this fungus measure 13—21 by 4—7 microns, thus resembling the fungus described by PENZIG and found by us.

In 1902 a third species of *Dothiorella* on citrus leaves from Sicily was described by SCALIA and given the name *Macrophoma aurantii.* The spores of this fungus are somewhat larger than ours and those of PENZIG and CELATTI. SACCARDO (21) gives 21—32 by 7—9 microns as the size of the pycnospores of SCALIA's fungus As discussed later, such dimensions may be included in the natural range of spore sizes of this *Dothiorella* species.

We, however, do not wish to make any definite statement on the identity of *Phoma Montegaziana, Macrophoma citri, Macrophoma aurantii* and our fungus before the type materials are compared.

A *Dothiorella* rot of citrus fruit, ascribed to *Dothiorella gregaria* Sacc. was recorded by FAWCETT (8) from Florida, California,

Texas, Sicily, Spain, Tunisia, Algeria, Cyprus, Japan, China, Brazil, Queensland, South Africa and South Rhodesia and by Baker (3) from Trinidad. A similar rot on orange fruit was described by us in Palestine (18). *Dothiorella* also causes a branch and trunk gummosis of lemon and orange trees in Palestine (16). A similar disease was reported by Fawcett (8) from California, Spain, Cyprus, Tunisia, Algeria and Japan, and by Fawcett (7) and Savastano (22) from Sicily.

Fawcett (6) and Horne (11) record that *Dothiorella gregaria* causes rot and blight of walnut and avocado in California. A similar rot on avocado fruit was reported by Doidge (5) from South Africa, under the name of *Physalospora perseae,* and then recorded by Abbot (1) from Peru. The pycnospores of this avocado rot fungus are given as 18—20 by 5—6 microns, greatly resembling the measurements for our fungus. Petrak and Ciferri (14) described a new species, *Dothiorella dominicana* on mango leaves with pycnospores measuring 13—22 by 5—7 microns. These spores seem to approach closely the size of the *Dothiorella* under discussion. Other records of *Dothiorella* on mango fruit were recently made by Wardlaw (29) in West India and by Su (27) in India.

In the determination of the taxonomic position of *Dothiorella* species it is very important to ascertain their relation to their perfect or ascogenous stage. Formerly this aspect of the study was in great confusion, Shear and his Associates (23) proved that *Dothiorella* belongs to the life cycle of *Botryosphaeria* and *Sphaeropsis* to that of *Physalospora.* The perfect stage found in our cultures isolated from citrus fruit showing *Dothiorella* rot is therefore a *Botryosphaeria.* In addition its ascospores are too narrow, short and fusoid to be a *Physalospora.* Shear's test (23) of germinating ascospores for the purpose of distinguishing *Botryosphaeria* from *Physalospora* could not be carried out.

The problem arises of ascertaining the species of our *Dothiorella* and *Botryosphaeria* isolated from the rots of banana and orange fruit. Fawcett (8) calls his fungus which causes a citrus fruit rot, *Dothiorella gregaria,* associated with *Botryosphaeria ribis* studied by Grossenbacher and Dugger (10) on currant cane. Fawcett also cites the pycnospore measurements found by these investigators for

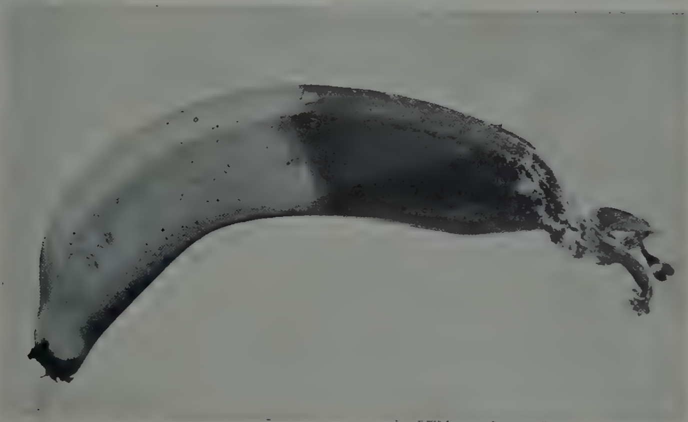


Fig. 1. Banana fruit attacked by Dothiorella rot.

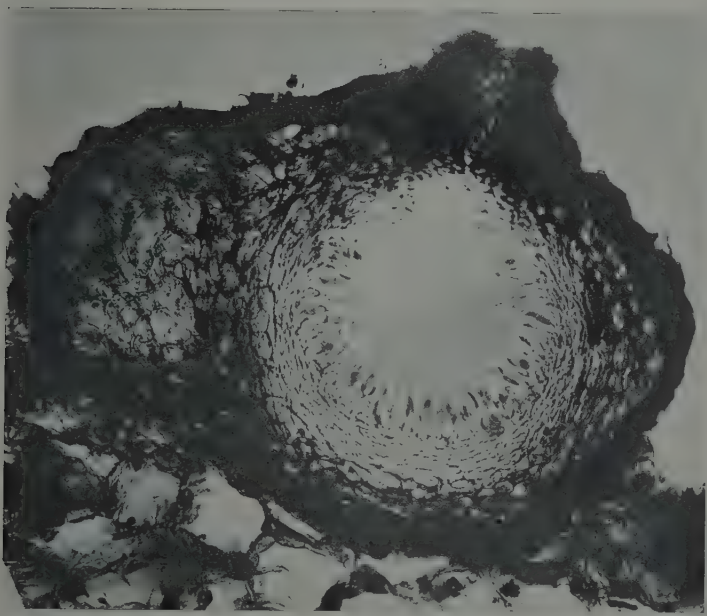


Fig. 2. Section through pycnidium of Dothiorella on banana fruit.

REICHERT AND HELLINGER — DOTHIORELLA ROT OF BANANAS AND ORANGES

the fungus isolated from currant cane and other hosts as characteristic of his *Dothiorella* of citrus rot. These measure 16—25 by 4.5—7.5 microns. On the whole we may say that the spore size of our *Dothiorella* from banana and citrus fruit and that of other hosts mentioned above agree with these measurements of FAWCETT, GROSSENBACHER and DUGGAR.

FAWCETT (8) again finds that the measurements obtained by GROSSENBACHER and DUGGAR of the ascospores of *Botryosphaeria ribis* of currant cane, 16—23 by 5—7 microns, agree with those of his citrus fruit rot fungus. These measurements also fit those obtained from our cultures of *Botryosphaeria* which developed from the *Dothiorella* rot of oranges, 15—19 by 5—8 microns. It must be mentioned, however, that smaller ascospores of *Botryosphaeria* were found on dead branches of old orange trees. These measured 11—14 by 3—4 microns. We are inclined to consider this deviation as a natural variation within the range of the species. SHEAR and STEVENS (24,26) emphasize the fact, based upon their examination of the fungus on many hosts, that the limits of the size of the ascospores of *Botryosphaeria ribis* are 13—28 by 4—12 microns, i. e. a range which enables us to include here the size of the ascospores isolated from citrus fruit in Palestine, and also those mentioned above as *Physalospora perseae* Doidge on the mango fruit rot and *Macrophoma aurantii* on citrus leaves. In any case the perfect stage of Doidge's mango rot organism is not a *Physalospora* but a *Botryosphaeria* as it is associated with a *Dothiorella* in its imperfect stage. PETRAK (13) examined Doidge's type material and found that her *Physalospora* is actually a *Melanops* which he renamed *Melanops perseae*. Some authors (4) consider *Melanops* to be synonymous with *Botryosphaeria*.

Nothing therefore prevents our following FAWCETT's example in considering our banana and citrus fruit rot organism, *Dothiorella gregaria* Sacc.

In support of such a decision we may quote C. O. SMITH's experiments (25) in which he succeeded in inoculating 50 species of plants, distributed among 39 genera and 20 families. It is difficult, however, to come to a definite conclusion in this matter as long as type material of SACCARDO is not available for examination, as reported by PETRAK and SYDOW (15), although SACCARDO's original des-

cription and spore measurements 22 by 6—6.5 microns agree with the *Dothiorella* under discussion.

More difficult still is the decision as to the identity of our *Botryosphaeria* with *Botrysphaeria ribis* G. and D. Morphologically they are very similar as already pointed out. Physiologically, however, our *Botryosphaeria* does not appear to be identical with the parasitic, chromogenic form of *Botryosphaeria ribis* used by the American investigators in their tests. This form is capable of producing a pink colour when cultured on starch-containing media (24, 10) and even on ripe apples containing starch, as shown by Fenner (9). Our *Botryosphaeria,* does not appear to belong to the chromogenic type as no pink colour was noticed when cultured on potato dextrose agar and on potato wedges. Grossenbacher and Duggar, however, describe a non-chromogenic type of *Botryosphaeria ribis* which is not parasitic. It should, however, be emphasized that Fenner (9) succeeded in inoculating apples with such non-chromogenic forms of *Botryosphaeria ribis.* Our strain thus resembles Fenner's form but seems to be more virulent. In any case, here also it will be possible to arrive at a definite conclusion only after a comparative study is made of all the strains concerned accompanied by inoculation tests on the currant cane.

Summary

1. A rot of banana fruits caused by *Dothiorella* has been recorded in Palestine for the first time. The disease is a typical tip-end rot, which progresses towards the stem-end. A characteristic feature of the disease is the fine white powder, on the rotten parts, the result of ejected pycnospores.

2. The pathogenic nature of *Dothiorella* has been proved by inoculation experiments. The pycnidial form was produced on banana fruits but not in culture.

3. The development of the disease seems to be favoured more by humid conditions than by temperature as its chief occurrence is during the wet winter months, while the fungus can develop at relatively low and high temperatures.

4. Cross inoculations on banana and citrus fruits, carried out with the banana *Dothiorella* and a *Dothiorella* found on orange fruits

proved them identical in the form of rot which they produced and in their morphological features.

5. Unlike the banana *Dothiorella,* the orange strain produced pycnidia on inoculated fruits and in culture, whereas a perithecial stage was obtained only in culture. A certain difference in the vigour of the two strains seems, therefore, to exist.

6. A review is presented of the occurrence of diseases on citrus and other fruit trees caused by a number of *Dothiorella* species described under various names but resembling morphologically the *Dothiorella* isolated by us from banana and citrus fruit rots in Palestine.

7. It was found that all the *Dothiorellas* mentioned resembled closely *Dothiorella gregaria* Sacc. given by FAWCETT and HORNE as the imperfect stage of *Botrosphaeria ribis* G. and D.

8. The perfect stage obtained from the *Dothiorella* citrus fruit rot in Palestine is a *Botryosphaeria,* and resembles *Botryosphaeria ribis* G. and D., but it differs from it physiologically, in being non-chromogenic on starchy media.

LITERATURE CITED:

1. ABBOT, E. V. (1929). Diseases of economic plants in Peru. *Phytopath.* 19: 645—656.
2. ARNAUD, G. and ARNAUD, M. (1931). Traité de pathologie végétale. Tome I. Paris.
3. BAKER, E. D. (1935). Citrus fruit-rots in Trinidad. *Tropical Agriculture* 12: 145—152.
4. CLEMENTS, F. E. and SHEAR, C. L. (1931). The genera of fungi. New York.
5. DOIDGE, E. M. (1922). A fungus of economic importance on the avocado (Persea americana) *Bathalia* 1: 179—186.
6. FAWCET, H. S. (1935). Melaxuma of the Walnut "Juglans regia" (A preliminary report). *Calif. Agr. Expt. Sta. Bull.* 261, pp .(133)—(148).
7. FAWCETT, H. S. (1931). Observations of Citrus conditions in Mediterranean countries I. Italy. *Cal. Citrogr.* 16: 914, 1132.
8. FAWCET, H. S. (1936). Citrus diseases and their control. New York.
9. FENNER, E. Aline (1925). A rot of apples caused by Botryosphaeria. *Phytopath.* 15: 230—234.

10. Grossenbacher, J. G. and Duggar, B. M. (1911). A contribution to the life history, parasitism, and biology of Botryosphaeria ribis. *New York State Agr. Exper. St. Techn. Bull.* 18, 113—190.

11. Horne, W. T. and Palmer, D. F. (1935). The control of Dothiorella rot on avocado fruits. *Cal. Agric. Exper. Sta.,* Bull. 594.

12. Penzig, O. (1887). Studi botanici sugli agrumi e sulle pianti affini. *Annali di Agricultura, Roma.*

13. Petrak, F. (1934). Mykologische Notizen XII. *Ann. Myc.* 32: 399.

14. Petrak, F. and Ciferri, R. (1930). Fungi dominicani. *Ann. Myc.* 28: 411.

15. Petrak, F. und Sydow, H. (1926/27). Die Gattungen der Pyrenomyceten, Sphaeropsidaceen und Melanoconieen. *Rep. spec. nov. regn. veg. Beihefte* 42 (1).

16. Reichert, I. (1934). The state of research in Citrus diseases in Palestine. *Hadar,* 7.

17. Reichert, I. and Hellinger, Esther. The third half-yearly report of the investigation of the fruit rots of Palestine, covering the period from September 1929 to February 1930 inclusive submitted to the Empire Marketing Board. London.

18. Reichert, I. and Hellinger, Esther, (1931). Citrus fruit diseases newly recorded in Palestine, *Hadar,* 4.

19. Roger, L. et Mallamaire, A. (1937). Notes de phytopathologie africaine. *Ann. agric. Afr. Occ.* 1. 187—206.

20. Saccardo, P. A. (1892). Sylloge Fungorum Vol. 10, Patavii.

21. Saccardo, P. A. (1902). Sylloge Fungorum, Vol. 16, Patavii.

22. Savastano, G. (1932). Una gommosi del limone causata da "Dothiorella". *Bulletino della R. Stazione di Patalogia vegetale di Roma, Nuova Serie,* 12.

23. Shear, C. L., Stevens, N. E. and Wilcox, M. S. (1924). Botryosphaeria and Physalospora on currant and apples. *Journ. Agric. Res.* 28: 589—598.

24. Shear, C. L., Stevens, N. E. and Wilcox, M. S. (1925). Botryosphaeria and Physalospora in the Eastern U. S. *Mycologia* 17: 98—107.

25. Smith, C. O. (1934). Inoculations showing the wide host range of Botryosphaeria ribis. *Journ. Agr. Res.* 49: 467—476.

26. Stevens, N. E. and Shear, C. L. (1929). Botryosphaeria and Physalospora in the Hawaian Islands, *Mycologia* 21: 313—320.

27. Su, M. T. (1934). Report of the Mycologist, Burma, Mandalay, for the year ending the 31st March, 1934. *Rep. Dep. Agric. Burma,* 1933/34: 25—33.

28. Wardlaw, C. W. (1935). Diseases of the banana. London.

29. Wardlaw, C. W. and Leonard, E. R. (1936). The storage of W. Indian mangoes. *Mem. Low Temp. Res. Sta., Trin.* 2.

A CASE OF REGENERATION OF THE GROWING POINT AT THE HYPOCOTYL

By KURT MENDEL.

(Division of Horticultural Physiology and Genetics, J. A. P. Agr. Res. Sta., Rehovot).

The formation of adventitious buds at the hypocotyl of decapitated seedlings giving rise to a regeneration of the growing point was observed only very rarely. Therefore it would seem justified to report any such occurrence.

Regenerations of this kind were recorded at the beginning of this century by KUESTER (3) and GOEBEL (1). (Both authors also mention older literature). These reports, however, remain solitary so that the regeneration from the hypocotyl was not even mentioned by KRENKE (2).

RAUH (4) recently published a comprehensive work on the formation of shoots at the hypocotyl. In this work especially the normal formation of shoots at the hypocotyl is investigated. In addition RAUH mentions regeneration from the hypocotyl of decapitated seedlings with the following plants: *Euphorbia bubalina, Linaria cymbalaria, Primula denticulata, Cyclamen persicum, Trifolium alpestre, Oenothera biennis, Symphytum ottomanum* and annual species of *Linum*.

As far as we know, regeneration at the hypocotyl of the decapitated seedling of a woody plant has not yet been reported before.

A case of such a regeneration of the growing point from the hypocotyl of an *Annona muricata* is reported below:

Seeds of this species were sown during May 1933 in the nursery of the plant introduction garden at the Agricultural Research Station at Rehovot. The seeds started to sprout about one month later and progressed very slowly. The cotyledons extricated themselves with

difficulty from the seed coat, so that either the tip of the plant remained in the soil, or the seed was lifted when the hypocotyl straightened. It was frequently necessary to remove the seed coat from the cotyledons in order to obtain normal growth of the seedling. On the 2nd of July, while removing the seed coats in this way, a seedling broke off in the middle of the hypocotyledon. The stump with the already well developed root-system was dug out and potted.

Numerous droplike protrusions (20—30) appeared 2 to 3 days later within the uppermost 1½ cm. of the stump (the total length of the broken hypocotyl was about 3½ cm.) Those pustules were found to be completely clear even when observed under a strong magnifying glass. They grew slowly during the following days and gradually became turbid. The largest of them appeared distinctly green about 8 days after the tip had been broken off. Observation under the magnifying glass and the microscope revealed that a differentiation had already started and that the protuberances represented rudimentary buds (Fig. 1 a, b). Those bud initials were hairy. The differentiation of additional pustules to rudimentary buds could be observed during the next few days. Hand sections were prepared from some of those buds, which showed the normal structure of a growing point.

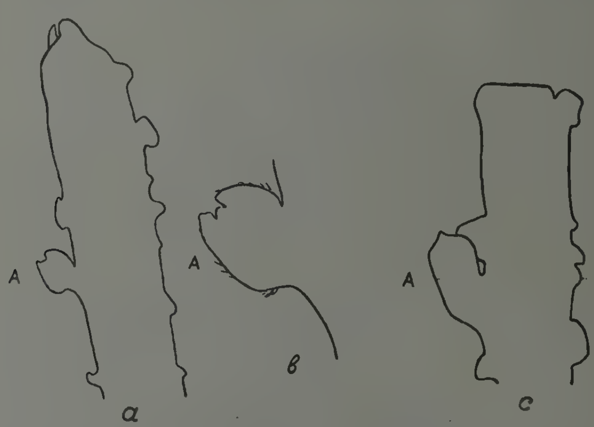


Fig. 1. The first stages of regeneration at the decapitated hypocotyl.
a) The broken upper end of the hypocotyl with adventitious buds; A — first bud differentiated.
b) Bud A, enlarged.
c) ,, A showing beginning of length-growth.

The first of the adventitious buds to differentiate started length growth, without as yet developing leaves, eight days after its appearance (Fig. 1 c). Another bud showed 3 days later an opened pair of leaves (Fig. 2 a) without previous length growth. On July 23rd, i. e. 21 days after decapitation ,the bud which had been the first one to differentiate had grown to a small branch of about 2 cm. with three normal leaves (Fig. 2 b). At this time all other buds had stopped their further development or were about to die off; even the bud which had already developed leaves (Fig. 2 a and b).

Fig. 2. a) The first bud unfolds its leaves.
b) The regenerated shoot (bud A of fig. 1). The bud with the unfolded leaves of fig. 2a is seen to have stopped its development.

Thus the regeneration of the growing point progressed very similarly to the regeneration of the hypocotyl of *Anagallis coerulea* [KUESTER (3)]. The regenerated organ represents, however, in our case a completely normal branch as contrasted with the process described by KUESTER (3). This author found distinct abnor-

malities of such regenerated shoots, especially the regular occurrence of *anisophyllia* of the first leaves of the adventious buds. Unfortunately KUESTER (3) does not mention the further development of the regenerate, so that we do not know whether the regenerated buds developed to normal plants, as we observed with our *Annona muricata.*

LITERATURE CITED:

1) GOEBEL, K. (1908). Einleitung in die experimentelle Morphologie der Pflanzen. Leipzig und Berlin, 260 pp.

2) KRENKE, N. P. (1933). Wundkompensation, Transplantation und Chimaeren bei Pflanzen. Berlin, 934 pp.

3) KUESTER, E., (1903). Beobachtungen ueber Regenerationserscheinungen an Pflanzen. *Beih. Bot. Cbl.* 14, 316—326.

4) RAUH, W. (1937). Die Bildung von Hypokotyl- und Wurzelsprossen und ihre Bedeutung fuer die Wuchsformen der Pflanzen. *Nova Acta Leopoldina, N. F.*, 4, 395—553.

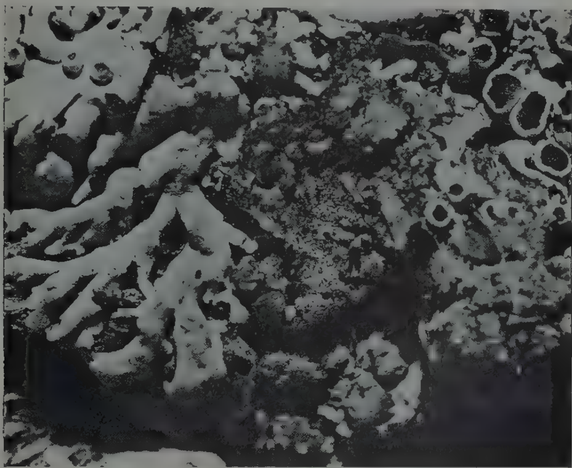


Fig. 1. Thallus of *Physcia Biziana* growing in association with *Parmelia Jacquesii.* The latter appears in the centre.

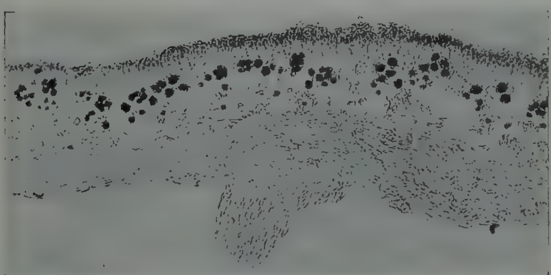


Fig. 2. Section through the thallus of *Physcia Biziana.*

REICHERT — PHYSCIA BIZIANA ON CEDARS OF THE LEBANON

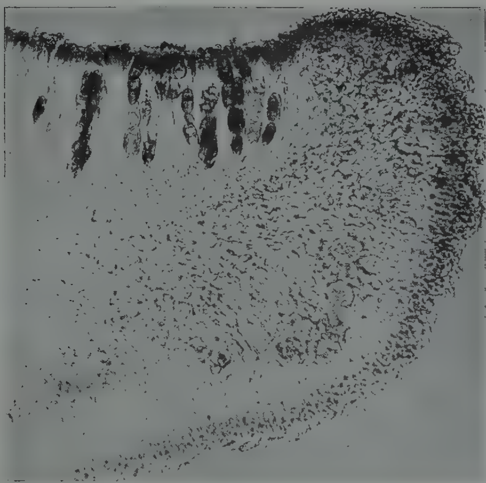


Fig. 1. Section of part of an apothecium of *Physcia Biziana*.

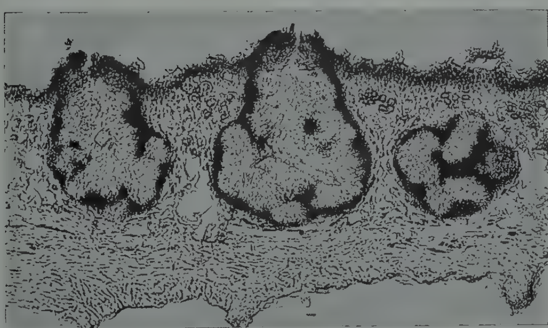


Fig. 2. Section through pycnidia of *Physcia Biziana*.

REICHERT — PHYSCIA BIZIANA ON CEDARS OF THE LEBANON

In Memory of
A. Zahlbruckner

PHYSCIA BIZIANA ON CEDARS OF THE LEBANON

By ISRAEL REICHERT

Physcia Biziana the lichen on which we report in this paper has been discovered by us on cedars of the Lebanon in 1934. Previously this lichen had been found in Dalmatia only; its newly observed occurrence is of great licheno-geographical importance. In the following a detailed description of the lichen and its habitat will be given as well as an account of the significance of its geographical distribution.

Occurrence

Physcia Biziana was found on old trees of *Cedrus libani* in various places on the Lebanon. It grows most profusely near Bsharra at a height of 2000 m above sea-level, on the trees of a cedar-grove which the Maronites regard as a holy place, and where lichen growth is little interfered with. The trees are said to be several thousand years old. Lichen growth is more rampant on the trees of the southern part of the grove which is not visited so frequently. In the northern part of the grove, however, lichen growth seems to be hampered by human disturbance.

Physcia Biziana profusely grows on the north-western side of the trees. It covers the whole stem and is noticed from afar by its white colour. It is often overshadowed by another lichen of brownish colour, *Parmelia Jaqucsii* Werner; growing side by side these two lichens sometimes intermingle (Pl. IX, fig. 1). They represent the principal association of the lichen vegetation. As lichens of lesser frequency and secondary importance mention may be made of *Anaptychia ciliaris,* various species of *Lecidea, Lecanora* etc.

Taxonomic position

Physcia Biziana has first been described by Massalongo (2) in 1856 under the name of *Squamaria Biziana*. Only in 1901 Zahl-

bruckner (7) recognized the *Physcia* nature of the lichen described by Massalongo. Two years later in 1903 he nevertheless described the same lichen collected by Baumgartner in Dalmatia under the new name of *Physcia ragusana* (8). In 1931, however, in his Catalogus Lichenorum Zahlbruckner united the two species, retaining *Ph. ragusana* as the name of the species and reducing *Ph. Biziana* to the rank of a variety (9). There is no justification for this procedure and Lynge (1) is therefore right in maintaining the validity of the prior name of *Ph. Biziana* given by Zahlbruckner originally, and in rejecting the name of *Ph. ragusana* subsequently given.

Physcia Biziana is characterized by its pruinose cover and the KOH-reaction of its upper cortex. As stressed by Zahlbruckner (8) and Lynge (1) it occupies an intermediate position between *Physcia pulverulenta* and *Physcia stellaris.* It differs from the former by its KOH-reaction, and from the latter by the pruinose cover of its thallus.

Zahlbruckner has described five forms of *Physcia Biziana* (= *ragusana*) : var. *cincrea* with a grey thallus and long, overlapping, slightly concave lobes; var. *argentata* with a white thallus and shorter, separate, sligthly convex lobes; var. *granuligera* with a granular centre; var. *pulvinata* with isidiose excrescences in the centre, and var. *saxicola* growing on stones, with a brownish centre.

The type found on the Lebanon which is dealt with in this paper is white in the centre, grows on trees and has neither isidia nor granules in its centre, so that the three last-named varieties can be excluded. As the thallus of our lichen is pruinose and markedly white and possesses convexly elevated lobes (Pl. IX, fig. 1) we may decide it to be identical with var. *argentata.*

Physcia biziana var. argentata

Physcia Biziana (Mass.) A. Zahlbr. var. *argentata* (A. Zahlbr.) Lynge which is found on the cedars of the Lebanon may be described as follows: Thallus of big size, diameter up to 7 mm, chalk—white and strongly pruinose. Lobes also adpressed to the substrate with their downwards inclined distal ends. The lobes are convex, profusely branched, their margins slightly apart from one another and not overlapping; lateral branches form at acute angles to the main branches; their ends are slightly crenate and incised (Pl. IX, fig. 1) The lower cortex is cream-coloured with 1—1.5μ long rhizines. The

upper cortex is colourless, 20—45μ in width, plectenchymatic with roundish-angular pseudocells. Gonidia 30—50μ thick, arranged in a regular layer below the upper cortex. Medullary layer 60—90μ wide formed by hyaline hyphae. The lower cortex is 40—120μ in width, formed by hyphae running parallel to the upper layer (Pl. IX, fig. 2). Apothecia more crowded towards the centre of the thallus, 1—3 mm in diameter, sessile, free from the thallus. Excipulum white, without rhizines, margin thick and incurved, entire, only occasionally crenate. Outer layer of excipulum plectenchymatic, with roundish pseudocells, 175μ in width. Cortex 40μ thick at upper part of excipulum, up to 100μ thick at its lower part. Gonidia crowded below cortex, further apart in medullary layer, and found below hypothecium as well (Pl. X, fig. 1). Discus plain to convex, black, non-pruinose. Hypothecium 290—300μ thick colourless. Hymenium 100—120μ thick, colourless, but brownish at the top. Paraphyses septate, brownish and club-shaped at the top, sticking to each other at their distal ends. Asci cylindric, 60—70μ in length and 20—25μ in width. Spores greyish-brown, ellipsoid-roundish, not constricted, embedded in a layer of mucus which is readily seen if stained with aniline blue. Spores with very thick walls especially at their centre and end, 18—25μ in length and 7—11μ in width (Pl. X, fig. 1). Pycnidia numerous, roundish-oblong, 145—260μ in length, 100—225μ in width (Pl. X, fig. 2). Fulcra composed of 6—8 basidia each of which measures 3—4.5μ in length and 3μ in width. Pycnoconidia attached immediately to the basidia, rod-shaped and ellipsoid, 2—5.5μ ling 0.5—1μ broad. The upper cortex is stained yellow by KOH, while the medullary layer remains unstained.

The description given here almost agrees with that given by Zahlbruckner (7, 8) and Lynge (1). The only distinction is the bigger size of the spores of our lichen; as mentioned before these measure 18—25μ in length and 7—11μ in width, whereas the figures given by Zahlbruckner and Lynge are 15—18μ and 5—8μ resp. In addition it must be emphasized that neither Zahlbruckner nor Lynge mention the existence of a mucus-layer in which the spores are embedded. An accurate study of the species which is at present in preparation will decide upon the exact taxonomic position of our lichen. In the meantime it may be considered identical with Zahlbruckner's species which it resembles closely in all except the above-mentioned characters.

Geographical distribution

Elsewhere we have previously reported our observations on the occurrence of *Ph. Biziana* in Palestine (5), Asia minor, Corfu, and Algeria (3, 4). In Palestine we have found the lichen on olive-trees near Rama on the highlands of Galilee, where precipitation is heavy and maquis forests are fairly well developed. The habitats of the lichen in the other countries mentioned have been learned from specimens kept in various herbaria under different names. From this it appears that the growth of this lichen is limited to the Mediterranean region within which it prefers localities of high altitude and humidity. We may therefore consider *Ph. Biziana* as a characteristic element of the atlantic-mountainous part of the Mediterranean region, but not of the entire Mediterranean region as we have stated in earlier publications (3, 4). Its geographical distribution resembles that of *Parmelia Jaquesii* (3, 4) with which it grows associated. Stress must be laid upon the fact that Werner (6) has found *Parmelia Jaquesii* growing in Marocco at an altitude of 2200 m on mountains with a typically atlantic vegetation, among the trees of which *Cedrus atlantica* predominates. The habitat of *Cedrus libani* on the Lebanon must also be regarded as very humid, as precipitation is heavy and the trees are frequently wrapped in fog even in midsummer. *Physcia Biziana* and *Parmella Jaquesii* can therefore be concluded to be typical representatives of atlantic vegetation.

I wish to express my indebtedness to the Director of the Naturhistorische Museum, Vienna, for lending me the material of *Physcia Biziana* for the study of the species, and to Prof B. Lynge for his help in this work. I have also to thank Dr. M. Chorin and Dr. S. Avisohar of the Division of Plant Pathology at the Agricultural Research Station, Rehovot, for their help in preparing the photographs and sections.

Summary

(1) *Physcia Biziana,* until now found only in Dalmatia, is reported to occur on cedars of the Lebanon.

(2) The habitat of *Physcia Biziana,* and the lichens growing in association with it, are described.

(3) The systematic position of the lichen is reviewed and the name *Physcia Biziana* var. *argentata* is decided upon.

(4) The morphology of the lichen is described in detail.

(5) The occurrence of the lichen is reported from other Mediterranean countries.

(6) *Physcia Biziana* may be considered as a Mediterranean-atlantic-mountainous element.

LITERATURE CITED:

1. Lynge, B. (1935). Physiaceae. Rabenhorsts Kryptogamenflora von Deutschland, Oesterreich und der Schweiz. Bd. IX, 6. Abt.
2. Massalongo, A. B. (1856). Miscellanea Lichenologica, Verona.
3. Reichert, I. (1936). L'Afrique du Nord et sa position phytogeographique au point de vue lichenologique. *Bull. Soc. Bot. de France* 83: 836—841.
4. Reichert, I. (1937). La position phytogeographique de l'Afrique du Nord au point de vue lichenologique. *La Revue Bryologique et Lichenologique*, N. S. 10: 37—46.
5. Reichert, I. (1937). Eine lichenogeographische Skizze Palaestinas. *Verhandl. der Zool.-Bot. Ges. in Wien* 86/87: 288—296.
6. Werner, R. G. (1932). Contribution à la flore cryptogamique du Maroc. *Rev. Bryologique et Lichenologique*, N. S. 5: 210—228.
7. Zahlbruckner, A. (1901). Vorarbeiten zu einer Flechtenflora Dalmatiens I. *Oesterr. Bot. Zeitschr.* 51: 26.
8. Zahlbruckner, A. (1903). Vorarbeiten zu einer Flechtenflora Dalmatiens II. *Oesterr. Bot. Zeitschr.* 30 pp.
9. Zahlbruckner, A. (1931). Catalogus Lichenorum Universalis, Bd. VII.

IN MEMORY OF HANS MOLISCH

By H. R. OPPENHEIMER.

With the death of HANS MOLISCH, which took place on December 8, 1937, Austria lost its most famous plant physiologist. MOLISCH was at the same time an outstanding physiologist, histochemist, bacteriologist and horticulturist.

He was born at Brno (Bruenn) on December 6,1856 as the son of a commercial gardener. Already during his early youth the profession of his father brought him in contact with the living plant. As a young boy he worked in the garden of his father and learned how to plant, root cuttings, graft and hybridise. During his boyhood be became acquainted with GREGOR MENDEL who lived as a priest in a monastery of his home town, taught at the gymnasium and visited occasionally the garden of his father. MOLISCH always considered his acquaintance with this famous scientist as one of the most precious experiences of his youth.

After graduating from the gymnasium he studied plant physiology with JULIUS WIESNER at Vienna, while he acquired his knowledge of chemistry from E. LUDWIG. At the age of 23 he received his degree of doctor of philosophy and became the assistant of WIESNER. In this capacity he cooperated with WIESNER between 1881 and 1889 in his investigations at the Institute of Plant Physiology at the University of Vienna. In 1885 he became a lecturer at this institute. From 1889 to 1894 MOLISCH was professor at Graz. Then he acted for 15 years as director of the Institute for Plant Physiology of the German University at Prague. Finally he returned to the University of Vienna where he became the successor of WIESNER in 1909 and directed the Institute of Plant Physiology until 1928. He visited this institute regularly until the last years of his life. This may be illustrated by a passage from a letter which he wrote to me in 1935: "It is an inner need for me to go up to my dear laboratory to perform there an experiment, to take a look through the microscope and to exchange

thoughts with my successor". He continued to publish in an interesting and original way until his last days.

MOLISCH collected considerable information during his travels. He undertook a scientific trip around the world in 1897—98. During this trip he spent much time on plant physiological studies at the botanical garden of Buitenzorg, Java. In 1922 he followed a call from the Japanese government to the University of Sendai (north of Tokyo), where he acted for three years as director of the Division of Botany at the Biological Institute. During 1928/29 he undertook a scientific trip to India where he met BOSE at his institute near Calcutta. He described his impressions of Japan and India in three books containing the results of his scientific investigations in those countries.

Nature had endowed MOLISCH with rich mental and physical abilities. He was a tall, well built man, whose bearing expressed at the same time self assurance, thoughtfulness and kindness. His features were unsually expressive. His high forehead, the observant dark eyes, expressive large ears and strongwilled chin showed, especially in his later years, features which somewhat resembled those of the old GOETHÉ. He had a striking appearance which fascinated at first sight.

The essential qualities of his character were truthfulness, simplicity, straightforwardness and clarity of thought and expression. Abstract science which expresses itself in clumsy language difficult to understand, was foreign to him. This expresses itself in the motto taken from BOLTZMANN which precedes his book on "Pflanzenchemie und Pflanzenverwandtschaft":

"Bring' vor, was wahr ist,
Schreib so, dass es klar ist,
Und verficht es, bis es mit Dir gar ist".*)

He was an outstandingly good observer and showed great skill in setting up experiments with simple means. He did not like clumsy and complicated apparatus: "One does not have to use cannons to shoot sparrows". He frequently emphasised how much might still be discovered in the field of botany by means of the every day simple equipment. His ability to do so is well illustrated by his book "Botanische Versuche ohne Apparate".

*) Publish the true, write it clearly and fight it through till your end.

The experiment was for him the basis of his inductive research. As soon as he had collected sufficient experimental data, his remarkable intuition permitted him to recognise easily the underlying principle. Whenever he criticized work of other students, he always distinguished himself by a superior impartiality. His publications are, therefore, free of all passionate polemics. He was a realist rather than a prophet and too distinguished to be influenced in his scientific opinion by feelings, such as personal sympathy or ambition. His magnanimity in the promotion of worthy students and assistants was great. Still he was bitterly disappointed by a man, towards whom he had shown much kindness, and who caused him much grief during his later years. Such experiences, however, did not let him despair in mankind. The consciousness of his abilities and the appreciation of his value permitted him to find ever new satisfaction in his work. This was the source of his optimistic attitude towards life which is typical of healthy, active and successfully creative men.

MOLISCH was a first rate academic teacher. His lectures were a source of rich information for his students, because his thoughts were logically developed and clearly formulated. He was able to base his lectures to an unusual degree on his own experiments, because of his manysided experience with the most varied subjects of plant anatomy and physiology.

He used his pedagogic talent with success for popular instruction, both in lectures and in writing. No German botanist can rival MOLISCH in his literary success. Especially his book "Pflanzenphysiologie als Theorie der Gaertnerei" went through six editions and was translated into several languages.

MOLISCH wrote 21 books and more than 200 scientific articles. He was awarded honorary titles at several universities. He was vice-president of the Academy of Sciences at Vienna, member of several academies and honorary member of numerous scientific societies. It is rather strange that until his last years no English speaking academy or society awarded him any of those honours. This might be explained by the fact, that to the best of our knowledge, his books did not appear in English. The author considers this fact the more deplorable, as MOLISCH's way of investigating and teaching conforms rather closely to English ways. The similarity in his way of thinking is also evidenc-

ed by the fact that he frequently visited the English Club at Vienna and liked using the English language.

If we present in the following the life work of MOLISCH, we shall not attempt to discuss in detail his various publications, but rather mention his most outstanding accomplishments.

In the field of the *physiology of environmental factors* the deceased studied the influence of extremes of high and low temperatures upon the plant. He devoted an entire book to the action of low temperature upon the plants, which appeared in 1897 under the title "Untersuchungen ueber das Erfrieren der Pflanzen". This work represents a continuation of the investigations by H. MUELLER-THURGAU and deals with a microscopic study of the freezing of tissues, during which the microscope stood in a low temperature thermostat. At first he studied the behaviour of gelatine gels, starch paste, various emulsions anad salt solutions, He always observed during freezing a separation of the dispersed phase from the dispersion medium. With gelatine or starch paste he found a netlike or spongy structure, similar to that observed with *amoebae* upon freezing. MOLISCH observed frequently with multicellular tissues, that ice formation took place outside the cell in the intercellular spaces, while the cell itself did not freeze. A large part of the water of imbibition was withdrawn from the protoplast during freezing even then when ice formation took place outside the cell. MOLISCH concluded from those observations, that *dehydration* of the protoplast was the primary cause of death by freezing. In this conclusion he associated himself with the views of FRANK and MUELLER-THURGAU. If his assumption were true, death had to occur at the time of freezing and not during thawing. This MOLISCH could prove with plants which permitted a recognition of the death point by chemical reactions.

GOEPPERT, who originated the theory according to which freezing itself already causes the death of the cell, had used as indicator the formation of indigo from indican which was observed with flowers of orchids. MOLISCH used the exomosis of *phycoerythrin* into the intercellulary spaces of red algae, which is connected with a change in colour, as well as the odour of *cumarin* which is given off after death by certain plants. In many instances he did not succeed to revive frozen plants by careful thawing except in the case of *Agave americana* where the conditions of thawing were of importance.

The views of MOLISCH did not remain uncontradicted. The theory, that the conditions of thawing are of fundamental importance, which had been postulated by DUHAMEL (1765) and SACHS (1860), has recently received considerable support by investigations of ILJIN. The observations by MAXIMOV, CHANDLER and ILJIN also discredit in general the dehydration hypothesis of death due to freezing. As a matter of fact, these phenomena are of a rather varied nature. It would be surprising, if plants of different frost resistance should behave similarly during freezing. The widely varying resistance of plants towards dehydration under conditions of *drought* may explain sufficiently their complex behaviour upon freezing. While more susceptible plants such as *Florideae* or *Ageratum*, which had been used by MOLISCH, died due to the withdrawal of water during freezing, others may be more resistant and thus survive dehydration, provided that a disorganisation of their structure due to the sudden imbibition of the protoplast during thawing is avoided.

We also wish to mention two of the secondary observations of MOLISCH on frost effects which are of lasting value, i. e. the realization of the importance of the *size of cells* in frost resistance, in as much as small cells are more likely to be undercooled than big ones. Furthermore MOLISCH showed, that the well known vitality of the stomatal apparatus also evidences itself by unusual frost resistance. He also studied the so called "chilling" of plants at temperatures above 0° C.

During a visit to the vulcanic areas of Japan in 1923—1925, MOLISCH had an excellent opportunity to study the *upper* limits of temperature for plant life. He studied the flora of some 300 hot springs. Only once did he find a higher plant, *Spirodela polyrrhiza*, which grew in water at a temperature of 35° C. On the other hand he identified numerous thermophilic bacteria and among them sulphur and iron bacteria. He found bacteria at water temperatures as high as 77.5° C, while *Cyanophyceae* could stand temperatures up to 69° C and proved to be the principal inhabitants of such hot springs.

Diatomeae which are often tolerant towards hydrogen sulphide were found less resistant to heat. For this reason, most thermae did not contain any green algae whatsoever. It is of interest that he found in one instance a septate fungal mycelium at 56.5° C. On the basis of his rich experience, MOLISCH expresses rightly some doubt

concerning the statements of other investigators, that thermal algae occur at temperatures of over 80° C. These statements might be based on incorrect measurements of temperatures. In order to explain the existence of life at very high temperatures, MOLISCH considers two possibilities: (1) that the protoplasts are composed of proteins which are especially resistant to heat and (2) that the proteins are protected from coagulation either by special protective substances or by the basic reaction of the cell fluids. In connection with these investigations MOLISCH developed a very interesting theory concerning the first living beings inhabiting the surface of the cooling earth, which he thought to have been representatives of the *Cyanophyceae*. These algae are autotrophic as well as heat resistant.

In the field of the *physiology of metabolism* we thank to MOLISCH the important statement (1892) that *iron* is absolutely essential to phanerogams as well as to cryptogams. The fact that this had not been recognised previously seems to be due to the frequent occurrence of iron in complex compounds: it is *masked*. In these cases, it can however easily be detected after ashing by means of the Prussian blue reaction, which was introduced into microchemistry by MOLISCH. It was MOLISCH who proved that chlorophyll does not contain iron as had been assumed before. He also made the observation, that many of the lower fungi and algae can grow without *calcium*. These all were discoveries of fundamental importance.

One of the subjects which MOLISCH enjoyed most to work on were the *mineral deposits within the cell wall*. He showed that the membranes of certain water plants (*Elodea, Vallisneria, Ranunculus, Myriophyllum*) accumulated manganese oxide in light, particularly in the median parts of the outer walls of the epidermal cells. With algae (*Oedogonium, Characium*) he observed a distinctly local accumulation of iron within the appressoria. Furthermore he showed that certain fungi, bacteria, flagellates and water mosses (especially *Fontinalis antipyretica*) accumulated iron within the cell wall by means of a vital process, while the fruits of *Trapa natans* and the leaves of *Potamogeton* accumulate iron *after death*. In the latter case the high content of tannin causes the precipitation of the iron.

MOLISCH showed, that the *deposition of silica* in the walls of *Cyperaceae* and *Gramineae* makes it possible to preserve the structure of the tissues after ashing sometimes nearly as well as in life. The

structure of such ash ("spodiogram") may sometimes be of diagnostical value for the anatomist, microchemist or taxonomist.

Important contributions were also made by Molisch towards the understanding of *carbon assimilation* in the green leaf. He showed that the formation of starch in light is strictly localised in the illuminated areas and (within certain limits) proportional to light intensity. This observation enabled him — by the use of cut out patterns — to print letters on leaves, which were rendered visible by means of Sachs' iodine test. In a similar way he reproduced photographs on leaves by fastening the negative onto their surface and "developing" the picture with iodine.

His proof, that even the dried i. e. the physiologically dead leaf may give off oxygen, is of considerable importance in as much as it shows that carbon assimilation is not necessarily a function of life processes. It depends, however, on a colloidal carrier, since solutions of chlorophyll are known to be unable to assimilate carbon dioxide. Molisch showed also, that the hydrolysis of starch which is a prerequisite for its transport away from the leaves does not take place, or is at least greatly reduced, under conditions of restricted transpiration

Molisch's *infiltration method* is a rather original discovery, permitting the determination of the degree of stomatal opening, which in its turn governs to a considerable extent the processes of CO_2 assimilation and transpiration. The ecologist estimates today by means of this method the degree of stomatal opening by observing with the naked eye the penetration of alcohol, xylol, benzol etc. into the intercellular spaces of the spongy parenchyma of the leaf. This method has been afterwards further developed by Linsbauer, Dietrich, Schorn etc.

Molisch also studied the *pigments* of the plant cell, particularly those related to chlorophyll which are active in assimilation. Thus he investigated spectrographically the green pigment of the purple bacteria named by him *bacteriochlorin* which could be extracted by means of alcohol and which proved to differ from the chlorophyll of higher plants. He thought that the *phaeophyll,* as we call the brown pigment of the *Phaeophyceae* since Ferdinand Cohn, is a modification of the true chlorophyll. This point of view is questioned by Willstaetter. The latter interpretes he brown colour of brown algae as produced by yellow pigments accompanying the true chloro-

phyll which occur here in larger proportion than in higher plants and thus hide the green pigment. To this MOLISCH replied that if WILLSTAETTER were right, it should be possible to separate the chlorophyll from the accompanying yellow and red pigments, which he did not succeed to do by the methods available at that time. GRAFE attempted to support MOLISCH's point of view in his "Chemie der Pflanzenzelle". It does not, however, seem tenable. By the way, MOLISCH also thought the yellow pigments of *Diatomaceae* and *Chrysomonadinae* to be similar to and easily convertible into chlorophyll.

His studies concerning the *phycocyanin* of blue algae and the *phycoerythrin* of the *Florideae* are well known. He had shown already in 1894/1895 that these pigments may be crystallized by salting out with ammonium sulphate. During 1906 he proved that phycocyanin does not represent a single compound, but a complex group of pigments, containing at least three different compounds. Today possibly one may doubt, whether those substances are actually chemically different from each other. *Phycocyanin* and *phycoerythrin* may be obtained from solutions in beautiful crystals by treating them with glacial acetic acid. In a similar way he was able to crystallize the anthocyanins. The importance of these investigations for the chemical study of those compounds is hardly diminished by the fact, that MOLISCH thought them to be proteins, which is apparently not correct. According to LEMBERG and BADER, the chromoproteids phycocyanin and phycoerythrin are made up of a protein and a pigment, which is related to chlorophyll and the gall pigments. One has to imagine, that these pigments are tied to proteins in a similar way as haemoglobin in the erythrocytes.

His experiments concerning the *modification of the anthocyanin pigments* of flowers in the living plant are of practical interest. Basing his experiments on the observations of gardeners, that certain soils change the pink color of *Hydrangea hortensis* into blue, he found that alum, aluminium sulphate and iron sulphate had a similar influence. The production of blue hortenses by means of the addition of alum to the soil has since become an established practice with commercial gardeners. Similar results were obtained by MOLISCH with other flowers. We also owe him observations on the change of flower colour with change in temperature. *Myosotis dissitiflora* shows a red color between 5 and 7° C, but is bluish at 15° C. *Syringa sinensis* and *Primula sinensis* have white blossoms instead of the usual

purple or red colour at high temperatures (30°C), apparently due to the inactivation of thermolabile enzymes. According to all these observations the anthocyanins and their behaviour in the medium of the cell sap are specific for different plants.

The *generation of heat and light* are important secondary phenomena of *respiration* which Molisch chose as subjects for his research. He was no doubt the most outstanding authority with respect to the emission of light by plants. We shall refer to these studies later. Concerning the heat produced by respiration he showed that a considerable rise in temperature could be obtained when transpiration of leaves is prevented by packing them tightly. With *Pyrus communis* he obtained a temperature of 59° C when he packed several kilograms of leaves into ordinary willow baskets. When he packed them into Dewar flasks, he needed only 100 to 150 grams in order to reach the same temperature. Blossoms of *Achillea* reached in those flasks a lethal maximum temperature of 43.6° C within 15 hours and a second maximum of 52.8° C three days later. The latter, however, occurred already after death and was caused by the respiration of bacteria, which decompose the tissues. The fact, that this considerable amount of heat of respiration produced by blossoms and leaves is usually not noticed, is due to the rapid loss of heat by radiation and evaporation.

The *physiology of plant excretions*, which is only little understood until today, owes to Molisch important contributions. It had been known for a long time that various *Araceae, Canna* and others excrete considerable amounts of water by guttation, if transpiration is prevented. It caused, however, surprise, when Molisch discovered in 1903 guttation of unexpected intensity from young leaves of *Colocasia nymphaeifolia* and *Colocasia esculenta,* which had not yet unfolded. He showed that the tips of those leaves excreted within a single night up to 100 cc of water. If the leaves stand in a slanting position, the water drops are ejected like from a jet with such rapidity, that it is difficult to count the individual droplets.

On his trips in the tropics he observed carefully the *secretion of sugar containing juices* from the inflorescence of palms, particularly of *Cocos nucifera* and *Arenga saccharifera,* the sap of which is used by the natives for the preparation of alcoholic drinks. He noted, that the secretion of sap starts only several days after the *wounding*

of the tissues which is caused either by repeated cuts (*Cocos*) or by hammering with a wooden tool (*Arenga*). The secretion is of a purely local nature, being caused by the irritated tissues, and is independent of root pressure.

Milk ducts are organs, the functions of which are not definitely understood, but they are thought by most investigators to be *organs of excretion*. MOLISCH discusses them in his "Studien ueber den Milchsaft und Schleimsaft der Pflanzen" (1901). The deceased showed, that the content of the milk ducts, which is emitted upon wounding, consists of a cell sap, which is most frequently acid and has to be distinguished from the granulate protoplastic layer lining the cellwall. In this he opposes the views of BERTHOLD, who thought the milk sap to be a "peculiarly transformed protoplasm". The milk saps were frequently found to be rich in *starch, protein* and *fats*. This composition of the sap would not seem to agree with the view, that the ducts are excretory receptacles only. The milk sap of *Cecropia peltata* appeared even as a genuine *protein store* consisting of small plasma bodies similar to leucoplasts. MOLISCH, who discovered them, called them *proteinoplasts*. The *elaioplasts*, which are synthesising oil, seem to be of a similar nature. MOLISCH found them in the milk sap of *Homalanthus populneus* and later on also in the epidermis of certain ferns. During these investigations he also made a number of important contributions to *cytology*. MOLISCH described nuclei, which were surrounded by a definite thick membrane. This feature was particularly prominent with the so called "bubble nuclei" (Blasenkerne) which he found in milk sap and later on also in *Nitella*. In the mucilage carrying vessels of *Lycoris radiata* he observed *threadlike nuclei*, which were frequently wound up into a ball and reached the unusual length of 1.5 mm with a minimum width. He showed the presence of *giant nuclei* in the resin ducts of *Aloe soccotrina*. These findings, together with the discovery of amoeboid lobed cell nuclei in *Campelia zanonia* (1918) show, to what extent MOLISCH enriched our knowledge concerning the *morphology of the nucleus*.

In the science of *physiology of growth* we owe to MOLISCH the discovery of the *warm water treatment* for the breaking of the rest period which has gained such importance in practical gardening. He found that even radium compounds and smoke were active in the breaking of the winter rest. He emphasized the importance of *sugar*

accumulation for the readiness of plants to blossom and to bear fruit. In doing so he stimulated research concerning the causes of the change between vegetative and reproductive growth periods which has recently attracted so much interest. He studied various causes of the *shedding of leaves,* such as soil humidity, increased transpiration and light deficiency.

Already at the beginning of the century, Molisch and his pupil Richter studied the growth inhibiting effect on seedlings caused by tabacco smoke, illuminating gas and the atmosphere of laboratories. After Huelin and Gane were able to show recently that the growth inhibiting influence and epinastic curving of leaves as well as the speeding up of the ripening of fruit, which is also produced in a similar way by gases given off from maturing apples, were due to *ethylene,* which had been given off by the fruit tissue, Molisch took up again those investigations in the year before his death. In this last work, which he called "Der Einfluss einer Pflanze auf die andere; Allelopathie" he described a multitude of experiments, which increased our knowledge of the physiological action of gases on different plant parts, not only if exhalated by apples etc., but also by roots and tubers. Molisch was also able to show, that these exhaled gases may act stimulating instead of inhibiting, if permitted to act only for a short time. Furthermore he showed that the gases from apples caused the dropping of leaves and blossoms. They also stimulate the growth of the tissue filling the lenticels of many woody plants and increase the tendency towards the formation of adventicious roots. The gases given off by apples were also found to increase the growth of pollen tubes, provided the exhaled CO_2 was permitted to remain in the germination chamber. If it was removed, however, these same gases had an inhibiting action. This book gives impressive evidence for the extent to which Molisch followed the current literature until his old age and still understood to discover unknown phenomena of nature.

Within the field of *tropisms* Molisch's observations on the *hydrotropism* of roots and its antagonistic relations to *geotropism* are remarkable. He also showed that negative *aërotropism* is an essential factor in directing pollen tubes into the tissues of the style.

He studied with particular interest the *sweet and salt water plancton,* because its metabolism presented a wealth of unsolved

problems. We mentioned already some of his studies concerning the *Cyanophyceae*. He was interested among other things in their relation to higher plants and mosses living with them in symbiosis. MOLISCH was able to to show, that a certain species of *Nostoc*, which lives in symbiosis with *Blasia pusilla*, was able to assimilate the gaseous nitrogen of the atmosphere. This finding was very important since the capacity of blue algae to assimilate nitrogen, had long been a matter of controversy.

He did considerable work on the *iron* and *sulphur bacteria*, which had been previously investigated by WINOGRADSKY. Contrary to findings of the latter, MOLISCH showed that the common iron bacterium, *Chlamydothrix ochracea*, which he was the first to grow in pure culture, did not require any iron and therefore was not dependent on the oxidation of ferrous compounds, as WINOGRADSKY had assumed. He was able to cultivate this bacterium saprophytically on manganese peptone which was free of iron. Nevertheless LIESKE established shortly thereafter the existence of typically *autotrophic* iron bacteria, which could not grow without iron, such as *Spirophyllum ferrugineum*. Such bacteria use the energy which is released upon the oxidation of ferrous bicarbonate to ferric hydroxide for the autotrophic assimilation of CO_2 and are definitely phobosaprobous. MOLISCH showed, that the formation of *iron hard pan* is caused, at least in certain cases, by the deposition of iron in the colloidal sheaths of iron bacteria. He discovered the iron bacterium *Siderocapsa Treubii* which is very common but had been overlooked.

In his work on *sulphur bacteria* MOLISCH studied primarly the species, which contain *bacterioerythrin*. We owe to him the discovery of a group of purple bacteria, named by him *Athiorhodaceae*, which he obtained in part in pure culture. They do *not* deposit sulphur in the body during their *saprophytic* metabolism. From this group he differentiated the *Thiorhodaceae*, which do accumulate sulphur. ENGELMANN had claimed on the basis of his studies with the latter group, that purple bacteria are autotrophic and that they assimilate CO_2 in presence of light by means of their pigment. MOLISCH, however, came to the contrary conclusion on the basis of his studies with the *Athiorhodaceae*. He found that purple bacteria required organic food and thought that they were unable to assimilate gaseous CO_2 because of their inability to give off oxygen in light.

Today we know that both investigators had been right in their way, in as much as the conclusion of ENGELMANN was correct for the *Thiorhodaceae* and those of MOLISCH, at least with respect to their saprophytic mode of living, for the *Athiorhodaceae*. On the other hand MOLISCH was not justified to conclude from the lack of evolution of oxygen, that no CO_2 assimilation takes place with the purple bacteria: as a matter of fact, this gas is immediately used up during the oxidation of hydrogen sulphide to sulphur, or of sulphur to sulphuric acid. Purple bacteria prefer a very low partial pressure of oxygen. They do not require gaseous oxygen from the atmosphere for the oxidation of hydrogen sulfide because they release oxygen from carbonic acid. With these organisms, reduction processes and oxidation processes providing energy are closely linked together.

As was shown above, MOLISCH discovered *bacteriochlorin*, the green pigment of the purple bacteria, which has been recently closely investigated by SCHNEIDER. By this author, it was found to be in structure as well as in function so similar to chlorophyll, that it is today called *bacteriochlorophyll*. The statement of MOLISCH, that *bacterioerythrin* had similar properties as *carotin* has been fully confirmed. Thus it is seen, that the investigations of MOLISCH in this field have been of considerable importance although he erred in an essential point denying generally the autotrophic character of the purple bacteria. Especially the grouping together of bacteria accumulating and not accumulating sulphur on the basis of their pigmental system has proven to be physiologically completely justified, since the ability of both groups to assimilate CO_2 in light represents an essential common character.

Only during his later years the attention of MOLISCH was attracted by *lime precipitating bacteria*. He was able to isolate organisms from sea water which precipitate the lime contained in the sea water in their immediate vicinity by the excretion of ammonium carbonate. Such a bacterium, isolated by him from sea water was described by him as *Pseudomonas calcipraecipitans* MOLISCH. He found a similar bacterium, *Pseudomonas caliciphila* MOLISCH in sweet water. Furthermore he showed that an *Actinomyces* and a *Torula* precipitated calcium *carbonate*, while certain bacteria living in the water could be shown to precipitate calcium *oxalate* in their surroundings.

His interest in the *light emitting organisms* reaches as far back as his stay in Prague. He found that most of the collected meat samples of beef, horse and goose contained the *Bacterium phosphoreum* (COHN) MOLISCH. This bacterium requires a large supply of oxygen and develops during the first days after the slaughtering of the animals. By placing the meat into a solution of sodium chloride the bacterium can develop to such an extent, that the meat appears in the dark as if covered with whitish stars. It grows best at lower temperatures. MOLISCH was able to grow phosphorescent bacteria in pure culture also from fishes and other dead sea animals. He cultivated *Bacterium phosphoreum* in Erlenmeyer flasks on a solid medium and used them at night as *bacterial lamps* which gave sufficient light to enable one, for example, to read the clock. If he had a bacterial suspension in a glass tube, which had stopped to give off light owing to lack of oxygen, it sufficed to turn the tube upside down in order to produce an emission of light effected by the passage of a single air bubble through the suspension.

He observed, that light was given off by dead wood, particularly if the mycelium of *Armillaria mellea* was present in it. The emission of light by leaves from the forest floor was first observed by him in the virgin forest of Java. He observed the same phenomenon later also in Europe.

During his trips, MOLISCH made frequent observations concerning the *phosphorescence of the sea,* in particular during his trip to Japan. Investigating samples of sea water, he found phosphorescent bacteria during his whole trip through the Mediterranean, the Red Sea, the Indian Ocean and the Chinese Sea. They were absent only at such places where large amounts of sweet water entered the ocean, e. g. at the mouth of the Yangtsekiang. *Peridineae* were found to be predominant causal organisms of the phosphorescence of the sea, the so called *lumen maris.*

DUBOIS showed, that phosphorescence is caused by a compound given off by the organisms, which he called *luciferin* and which MOLISCH had named before *photogen.* This *luciferin,* according to DUBOIS, is oxidized with the emission of light by an oxidizing enzyme, the *luciferase.* BUCHNER assumed, that the fluorescence of animals is in all cases due to symbiosis with fluorescent bacteria. To this, however, MOLISCH objected on the basis of his own observations.

It would lead too far trying to enumerate here the innumerable exact and reliable observations, which Molisch contributed to plant *anatomy* and in particular to *cytology*. It is sufficient to skim over a book, such as the standard work of Kuester "Die Pflanzenzelle" in order to find in almost every chapter references to the observations of Molisch. This is particularly true for the cell inclusions, which he investigated continually for many years. Molisch compiled his contributions toward the methods of determining the anorganic and organic contents of the plant cell in his famous work on the "Mikrochemie der Pflanze". The extent to which his contributions in this field were appreciated by his professional colleagues found its expression in the fact that they honoured Molisch's 80th birthday by a special volume of the journal "Mikrochemie".

His contributions to *horticultural science* have been mentioned here already. His "Pflanzenphysiologie als Theorie der Gaertnerei" supplied a basic presentation of the subject. He was considered in Europe the Nestor of this very modern branch of applied biology. He also was among the founders of the periodical "Die Gartenbauwissenschaft" which was established by Gleisberg and others.

The above appreciation of his accomplishments should portray Molisch as one of the most versatile and productive biologists of his epoch. Dedicating this article to his memory, the writer parts from his beloved teacher with deep mourning.

RICHARD FALK

(to his 65th birthday)

By I. REICHERT

In normal times the mycologists of Germany would have celebrated in 1933 the 60th birthday of Professor RICHARD FALK, one of the greatest mycologists of our times and one of those outstanding personalities who have made German science famous all over the world. It was a tragic fate that in that year he was dismissed from his position of Professor at the College of Forestry, Hannoversch-Muenden, by reason of the new Aryan laws. We feel it a duty as well as an honour to acquaint our readers with what Professor FALK has contributed to science and what we owe to him. May this our appreciation afford him some measure of consolation.

RICHARD FALK was the last—and undoubtedly the greatest—pupil of that classic of German mycology OSKAR BREFELD. Like his teacher, FALK at first prepared for a practical career. Both of them in their youth studied pharmacology; BREFELD in order to succeed his father as pharmacist, but FALK because he had little other choice. He feared that if he chose the career of scientific research which he most fervently desired, he would not be allowed to advance with his work because he was a Jew. In 1897 he passed the state-examination in pharmacology at Koenigsberg, and in 1899 he finished his studies as a food-chemist in Goettingen. 1900 was a most critical year in FALK's career. The time had now come for him to engage on the practical side of what he had studied, but at heart he felt no inclination to do so. His interests circled about forests and the plants they harbour, and particularly about fungi. These delicate little plants which appear as quickly as they disappear appealed to him before all others when he wandered about in the woods and observed their growth.

FALK himself tells us in his first mycological publication (1)

what thoughts in those days used to enter his mind on his walks in the forests:

"Whenever in autumn I strolled through the woods and observed the conspicuous figures of the big mushrooms, the question invariably occurred to me 'Why should not these plants, the majority of which are already known and highly valued as food for human consumption, be grown on a large scale and their qualities be exploited as systematically as those of the green plants? Just as our crop-plants are raised on the fields so mushrooms could be grown on the forest soil". Such were the problems that occupied his mind. But how was he to tackle and solve them, tied as he was to a career so different from what he desired? Young FALK was in a serious plight.

Help came to him from where he least expected it. In 1901 FALK had to serve in the army and he happened to be sent to Breslau which was noted for the research on cryptogams carried out there. Here lived and worked the great bacteriologist FERDINAND COHN, the founder of the *"Cryptogamic Flora"* and JOSEF SCHROETER who wrote the most comprehensive and best flora of fungi that any mycologist has ever written. At that time FERDINAND COHN'S successor OSKAR BREFELD was in charge at the university, the man who has achieved world-wide fame by his research on the growth of various fungi in cultures and the discovery and working out of their hitherto obscure life-cycles. FALK went to see him and asked for the permission to work in his laboratory in his spare time from his military duties. To this BREFELD agreed, and seeing his exceptional enthusiasm and skill, suggested that he should do some research work as a thesis for the Ph. D. degree under his, BREFELD'S, direction. BREFELD proposed a subject which was the continuation of his own research: The investigation of the connection existing between the vegetative spores of certain fungi—the oidia—and their perfect form, the fruiting bodies. In the course of this work FALK greatly distinguished himself. He succeeded in discovering the perfect types—various Basidiomycetes—to which those oidia belong. Immediately after he acquired the degree of Ph. D. BREFELD appointed him to be the first assistant at his Institute of Plant Physiology.

FALK took up his work with great zeal and deep devotion to his teacher Professor BREFELD, who was at that time particularly

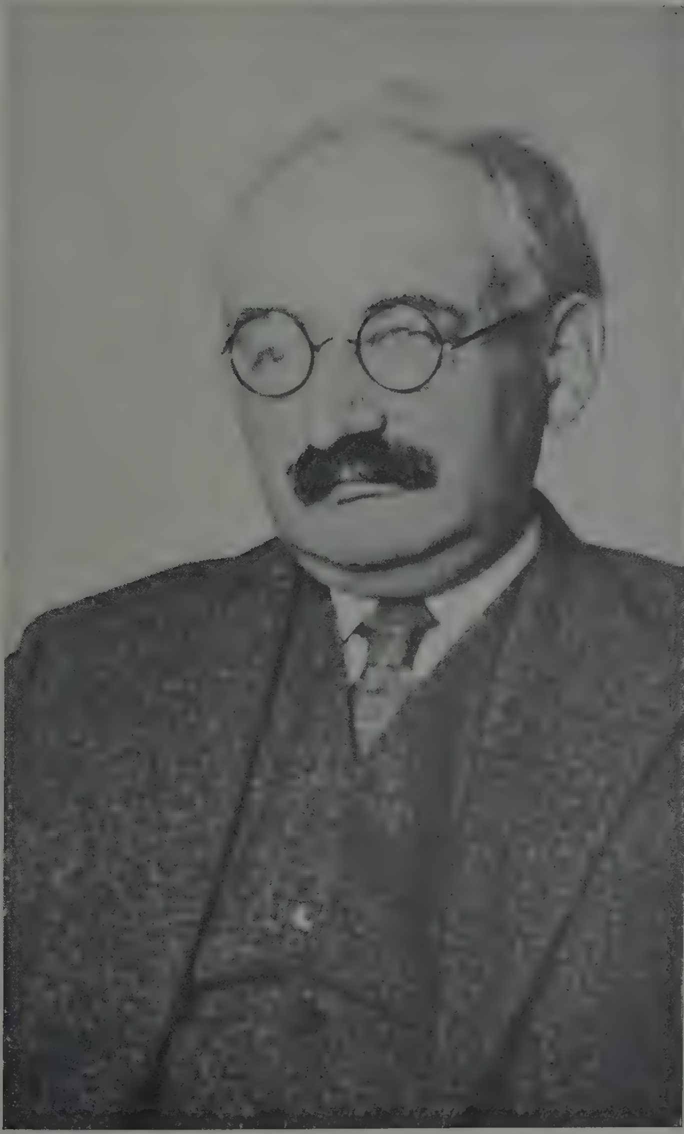
dependant on help and assistance. The one eye he had left and with which he had carried out all his experimental work was growing weaker and made microscopic investigation difficult for him. He therefore turned for help to his student and assistant. FALK helped him for 5 years in loyal devotion. He took over part of the administrative work as well as of the lectures and carried out various experimental work on his behalf. Great and important was the research he did for BREFELD on the mode of infection of wheat and barley plants with loose smuts (*Ustilago tritici, U. nuda*).

In his earlier experiments BREFELD had not succeeded in tracing back the development of the disease on these plants. In this case the infection of seeds by the fungal spores collected from the affected ears did not yield positive results as in the case of covered smut of wheat and barley (*Tilletia tritici, Ustilago hordei*), where BREFELD had definitely demonstrated these spores to be the cause of infection. FALK worked on this problem for 5 years and carried out special experiments on plots near Breslau specially provided for this purpose. As the result of these investigations he discovered that this loose smut differs from all other cereal smuts in so far as it is being propagated not by infection of seeds but by the infection of flowers. From diseased ears spores are dispersed by wind at the time of flowering, penetrate the stigma, and establish a mycelium within the seeds. When in the following year contaminated seeds are sown, the mycelium hidden in them grows up through the plant until it reaches and infects the ear. This discovery which was of eminent scientific as well as practical value has appeared in detail in volume 13 of BREFELD's great work on fungi, and was published by BREFELD under his own and FALK's name in 1903 (3). FALK had to give up his research on smuts as he was charged with work more urgent from a practical point of view. Nevertheless he was able to contribute another publication on this subject (6). It appears, however, from FALK's own words in his biography of BREFELD that the bulk of his material still awaits publication (18).

At that time serious damage by fungal growths became apparent in houses built of timber. Scientists held the fungus *Merulius lacrimans* to be the cause of this damage. Mycologists then could neither explain the origin nor development of this plague, nor

could they offer any advise how to fight it. They believed the fungus to come from the forests, its natural habitat, where it attacked the trees. Medical men suspected Merulius rot to be harmful to man and began to investigate it and to search for the best means to combat it. Thus the well-known hygienicist Prof. FLUEGGE for example began to study this problem. The Prussian Ministry turned to the greatest German mycologist. Prof. BREFELD, with the request to take up the study of this pathogene. BREFELD suggested that FALK should be entrusted with the necessary research. The Ministry followed his advise and charged the young FALK with this task, appointing him at the same time as member of a commission under the chairmanship of the famous mycologist ALFRED MOELLER, Professor of Forest Pathology at the College of Forestry, Eberswalde.

FALK tackled this work with great energy. In a short time he succeeded in collecting fundamental experimental evidence on which he published a paper. This was printed in 1906 still under the auspices of medical science, in the Journal for Hygiene and Infectious Diseases (4). This fact clearly shows how small was the interest taken by mycologists of those days in the questions of timber pathology. Doctors were the only people to take the problem seriously. FALK published in his paper the first results of the experimental research he had begun. In the first place he had to explore the belief widespread among mycologists at that time that the house fungus *Merulius lacrimans* originates in the woods and that from there it is introduced into houses by timber. FALK compared the variety of *Merulius* found in houses with that found in forests, and discovered the two fungi to be distinct from each other in their parasitic, physiological and morphological properties. The *Merulius* of the forests does not infect timber of houses and conversely the *Merulius* found in houses does not infect forest-trees. The *Merulius* occurring in forests has an optimum growth temperature of 22—24°C, and a maximum of 34°C, whereas the optimum and maximum of the house-fungus are 16—22°C and 27°C respectively. FALK accordingly divided the old species *Merulius* into two new species. It follows therefore that the source of infection of the house-fungus is not to be sought in the woods, but in the affected houses themselves. FALK then proved experimentally that the spores are spread from house to house by the air.



RICHARD FALK

To his 65th birthday

In the course of his research into this trouble, FALK discovered that there is a whole series of fungi which cause the rotting of timber. On one of these pathogenes which appears in the house in the form of dry rot and is caused by the fungus *Lenzites* he published a detailed monograph of 234 pages in 1909 (7). This work which includes an accurate description of the morphology, physiology and ecology of this fungus and the means to control it made a great impression on scientists and practical men alike. The well-known plant pathologist ERNST SCHFFNIT who reviewed this work in the Centralblatt fuer Bakteriologie Vol. 27, p. 281, 1910, writes on it as follows: "Since Hartig, the fungi destroying wood have hardly ever been the subject of so comprehensive a study." SCHAFFNIT also relates to us how hard were the conditions under which FALK did his work, and writes: "Whoever knows the primitive devices and modest means with which the author has carried out his investigations for years, will appreciate the work all the more for that."

In 1910, a short time after the publication of this work, FALK was appointed Professor in charge of Technical Mycology at the College of Forestry at Hannoversch-Muenden. Now began the great creative period of the young scientist. Here he published his great works which made him known throughout the world as the greatest expert on the rotting of timber. In 1913 he began the periodical publication of the research carried out in his laboratory under the name of "Mycological Investigations and Reports". In addition he was made editor of the periodical "Hausschwammuntersuchungen" after ALFRED MOELLER had died. FALK'S laboratory became the most important centre for the pathology of forests and timber in Germany. Students from many countries flocked to him and it suffices to recall the work of MELIN on mycorrhiza which was done under his guidance in Muenden.

Only two years after FALK had come to Muenden he already completed a great monograph on *Merulius* itself. (9). This work represents the climax of FALKS' creative life and the greatest and most comprehensive of his mycological works. What SCHAFFNIT said about his work on *Lenzites* equally applies to this work: A monograph of classical significance. In the whole of mycological world literature there has never been written as exhausting a work on the life-cycle of a single fungus, based on as many original experiments

and biological observations as this work. It is difficult to give here a correct impression of the wealth of details included in the monograph. The part dealing wth morphological and anatomical description alone comprises 218 pages. He divides the old species *Merulius lacrimans* into 4 new species and describes their morphology, physiology and ecology in detail. He also decribes other fungi associated with *Merulius* in causing rot of timber. In 118 pages he described the mechanism of dispersal of the fungus by spores and the laws governing their spreading. His description of the measures to be taken to control this plague of timber-built houses covers 60 pages.

Among the important practical results of this monograph on *Merulius* we have to think in the first place of the fact that here for the first time an accurate description was given not only of the *Merulius* which everybody knew to be a domestic pathogene but also of all the other fungi which cause the rotting of the timber of houses. The most important of them are different species of *Coniophora, Poria vaporaria, Paxillus acherantius, Ochroporus aedalis* and various species of *Lenzites.* The second result of this work was the discovery that the fungus *Merulius* does not affect timber unless previously attacked by the fungus *Coniophora* which gets into it even before the timber has been used for the purpose of building and which alters the chemical composition of the timber so as to make it acid in reaction. An attack of *Coniophora* cannot usually be seen with the naked eye, and he therefore called it dry rot. Without previous penetration of the wood by *Coniophora,* no infection by *Merulius* can take place. The practical conclusion to be drawn from this discovery was that—in view of the fact that all the wood used as timber in building houses may possibly be infected with dry rot to begin with—there was an urgent need for control measures to be devised to protect wood from infection by fungi before it is used in building.

This work on the immunisation of wood and its protection against the attack by destructive fungi was the third great task to which Falk devoted much time and energy, and in which he likewise achieved outstanding success. First of all he had to devise for himself methods for the exact comparison of toxic effects on fungi. These methods were later accepted by the conference for the protection of trees, which took place in Berlin in 1921, as international standard methods for the examination of fungicides for the preservation of

wood from rotting (12). In the course of years FALK examined more than 50 fungicides belonging to various groups of chemicals. He succeeded in finding toxic substances which at the same time render wood fully immune against fungi as well as insect attack. In the end he was even able to find a combination of immunifying materials protecting the wood not only from fungi and insects but also from fire (24). Among the fungicides which he discovered and which were introduced into practice those best known are sodium fluoride and the butyl-esters of acetic acid. FALK further succeeded in perfecting the technique of these methods so that they were both easy to put into practice and of highest toxic efficiency. In a paper which FALK gave into print with the publishers Fischer, Jena, in 1933, but which was put into circulation only in 1937 due to the help of the Polish Government, he reviewed the results of his work on the protection of wood by chemical means (26).

The great task which FALK had been confronted with in 1905 when the commission for research into the rotting of timber was formed by the Prussian ministry, had thus been entirely solved. In the above-mentioned paper published by the Polish Government in 1937 (27) FALK says himself: "The investigations with which I was officially charged since 1905 in the course of years lead to results by which the theoretical problems underlying the protection of timber in the erection of buildings can be considered essentially solved." Seldom men can speak of the completion of the work of their lifetime with so much confidence.

But FALK achieved much more than that which may be considered his life work i. e. the solution of the problems of protecting wood from destructive fungi. He also investigated the life-history of the important fungi causing the rotting of wood in the forest itself, and while stored in timber-yeards. A short review containing however a wealth of information on all fungi of the forest as well as the house causing destructive rotting of wood and the measures to be taken for their control, has been given by FALK in his paper published in 1937 by the Polish Government. This really sums up the work of a whole lifetime (27).

But FALK himself as we can see from his most recent researches does not consider his work on the subject of the preservation of wood to have as yet reached its conclusion. He wants to prepare

detailed monographs of all fungi destructive of wood which he has met with, on the lines of his classical monographs on *Lenzites* and *Merulius*. And in 1937 in fact a new monograph of this kind on *Ptychogaster* has appeared in Jena under the auspices of the Polish Government. Monographs on *Coniophora, Paxillus* and *Poria* are still lacking and we hope that the scholar may succeed in preparing them in the near future.

FALK's mycological work has been done with a practical end in view but nevertheless his findings can claim the greatest importance in the field of general biology of fungi. He was the first to discover that with fungi the process of growth is not periodical, as in the case of green plants, but takes the form of a uniformly progressing development which is not interrupted until the substrate becomes exhausted. He demonstrated that each fungus exhibits a constant progression of growth which can be expressed by the formula $s=c. z.$ where s stands for increase in length, z for the time and c for the speed of growth. By means of this formula constant values can be calculated for each fungus. In his view the increase in length between zero and optimum points is proportional to the rise of temperature. He discovered that complete harmony exists between the laws of development of fungi and the laws of pressure of Mariotte-Gay Lussac-Van't Hoff. The rate of growth in length depends on the microscopic diameter of the mycelium and it is a constant figure with each fungus (5).

FALK in his research on the fungi destructive of wood opened up entirely new aspects by his work on the ecology of their life. He showed that each fungus has a life-cycle of its own in which special ecological adaptations to the habit of trees exhibit themselves. Thus for example the growth-habit of fungi attacking the upper parts of trees or the topmost layers of wood stored outside the forests is different from the habit of fungi growing on the lower parts of trees or on the bottom layers of stored wood. The former FALK calls geodistomycetes, and the latter geoproximycetes. The geodistomycetes love sunlight and for this reason their optimum temperature is high, whereas the geoproximycetes have a lower optimum temperature as they are far less exposed to sunlight. This ecological specialisation finds its expression in the anatomical structure of fungi as well. The mycelium of geodistomycetes penetrates deeply into the host in form

of a solid mass while the mycelium of geoproximycetes spreads superficially. On the strength of these findings of FALK it is always possible to predict from the outset which fungi are likely to attack the wood. A typical example of geodistomycetes is *Lenzites*, while *Paxillus* is representative of the geoproximycetes. FALK made his first observations on the ecology of fungi as early as 1906 (4) in the beginning of his mycological work. In the same year he published a new experimental work of 100 pages on this problem (5). He continued with these investigations all the time and in his great monographs always devoted large sections to ecology.

Another biological problem which interested FALK from the beginning of his work is the question of the development of spores and the laws governing it. In practice he came across this problem for the first time when he wanted to determine the functions of spores in spreading *Merulius* from house to house and the way in which they get into the air and from there into neighbouring houses. The opinion prevailing then among mycologists under the influence of DE BARY was that the process of dispersal of spores could be explained by the water-loss of fungal fruiting bodies. But FALK proved experimentally that spores are being liberated from the fungus even if water is not lost. He showed by continued exact experiments that two distinct processes are concerned in the dispersal of spores by air and their spreading from place to place: first the process of liberation of spores from the fruiting body and second the process by which the liberated spores are dispersed. The basidia serve the basidiomycetes and the asci serve the pyrenomycetes as precise and delicate apparatus for the liberation and dispersal of spores. When they get ripe the basidia as well as the asci possess a potential and kinetic energy which makes the former drop and the latter forcibly expel the spores contained in them. The stratum of air into which the spores fall or are expelled is in a state of motion caused by the difference between its own temperature and the self-produced heat of the fruiting bodies. This current of temperature—as FALK calls that very fine current around the fruiting bodies—suffices to rouse the spores and to convey them into the sphere of wind-currents which further disperse them in all directions. By means of extremely delicate experiments FALK demonstrated the discomycetes to be poor in potential energy of their own; they are therefore dependant on the help of sunrays falling on

the fruiting bodies to create temperature differences between the fruit and the air. Thus the spores are liberated from the fruiting bodies and enabled to reach the sphere of wind-currents. Falk also made mathematical calculations of the speed of spore-movements and came to extraordinarily interesting conclusions. On the basis of the mechanism of spore dispersal he divides the order of fungi into various biological groups (2, 8, 10, 11, 14, 21).

Falk's biological investigations disclosed the interesting fact that there are two types of fungi attacking wood. One type causes the decomposition of the lignin as well as of the cellulose of wood; this action Falk calls "corrosion". The second type of fungus disintegrates only the cellulose of wood, but not the lignin. The latter is preserved and accumulates to form humus. Layers of peat and coal owe their existence to the help of this type of fungus, the action of which Falk called "destruction". Fungi of the corrosion-type therefore decompose humus while fungi of the destruction-type produce the humus necessary for the nutrition of trees. The great practical significance of the knowledge of these properties of various fungi can well be imagined (19, 22, 23).

All these his biological experiments and others which we could not mention here served Falk as material for a new systematic classification of the order of fungi on a biological basis, in contrast to or supplement of the hitherto accepted classification based on morphological features. This new classification he always bears in mind and in all his new researches he finds evidence in its support. In his new monograph on *Ptychogaster* (25), too, which was published in 1937, he quotes new evidence supporting this classification. Although all these efforts of Falk have not succeeded in superseding the previously accepted morphological and phylogenetic classifications, they nevertheless disclosed entirely new aspects of the ecology and biology of fungus life. In connection with this work we may recall the above-mentioned review by Ernst Schaffnit of Falk's monograph on *Merulius,* in which he also writes: "By the basic approach chosen for his research the author can undoubtedly be said to have proved successfully the value and importance of a biological basis for the study and systematic classification of fungi." These words Schaffnit wrote 28 years ago and from that time until to-day Falk

has added many important contributions to our understanding of the biological functions of fungi.

FALK did not limit himself to research on the protection of trees from destructive fungi but endeavoured to discover ways and means for the exploitation of the fungi themselves—parasites as well as saprophytes—for constructive purposes, i. e. the production of substances useful to man. This really had been the first idea which took his fancy and which he had also expressed in his above-mentioned first scientific publication (1). He devised special methods by which to obtain acids of economic value with the help of moulds like *Penicillium, Aspergillus* etc. These fungi he raised on a substrate of carbohydrates gained from the residues of cultivated plants to be discarded or even from wild plants of no economic value at all. By means of a special technique easily put into practice FALK succeeded in obtaining very high percentages of citric acid, tartaric acid, malic acid, gluconic acid and other acids (16, 17).

FALK did not give up either his original idea of finding easy ways for the cultivation of mushrooms for human consumption. He tried out new methods of growing mushrooms on the stumps of felled forest-trees (13). With the help of his wife OLGA FALK he has done much detailed work in order to determine the conditions under which the spores of the common mushroom germinate (15). The end he has continually in view is finding a method of propagation not by the mycelium as is the usual way up to date, but by spores. He found that the speed and vigour of germination can be increased considerably, if to the spores is added either a small quantity of various acids (e. g. succinic acid) or the mycelium of certain fungi (e. g. Coprinus) which produce acids. FALK brings this fact into connection with the ecological phenomenon apparent in the natural growth of the common mushroom (*Agacicus campestris*) which mostly prefers habitats with acid reactions. It is also known that *Coprinus* grows in the same places as the common-mushroom but usually precedes it, so that the mushroom grows on a soil previously rendered acid by *Coprinus*. As far as I know, FALK has continued to work on this problem and has come to interesting conclusions which he has not yet published.

FALK'S great and flourishing work was brought to a standstill in 1933 as explained above. In that year while on his travels in

mediterranean countries he also came to Palestine. He remained in this country for a year but to our deep regret he did not find work suitable for him. In 1936 he was invited to the Institut de Recherches des Forêts dominales de Pologne. The scientific world owes a debt of gratitude to Poland because it has given this scientist the chance to continue with his experimental work on the protection of trees. Mycologists of all the world are impatiently looking forward for him to complete his monographs on the fungi of wood and forests, and particularly his comprehensive monograph on the protection of wood.

We wish him and his wife OLGA FALK, his foremost helper in his research work, that they may be long spared for scientific research, and be given an opportunity to continue their work in the Holy Land, the land of the past and the future of Israel.

SELECTED PUBLICATIONS OF FALK MENTIONED IN THIS ARTICLE

1. FALK, R. (1902). Die Kultur der Oidien und ihre Rueckfuehrung in die hoehere Fruchtform bei den Basidiomyceten. 36 pp., Breslau.
2. FALK, R. (1904). Die Sporenverbreitung bei den Basidiomyceten und der biologische Wert der Basidie. *Beitraege z. Biologie d. Pflanze von F. Cohn,* 9, 1—82, 6 plates.
3. BREFELD, O. und FALK, R. (1905). Die Blueteninfektion bei den Brandpilzen und die natuerliche Verbreitung der Brandkrankheiten. *Brandpilze (Hemibasidii)* IV, 13. Heft,
4. FALK, R. (1906). Ueber den Hausschwamm. *Ztschr. f. Hygiene und Infektionskrankheiten* 55, 487—505.
5. FALK, R. (1907). Wachstumsgesetze, Wachstumsfaktor und Temperaturwerte der holzzerstoerenden Mycelien. *A. Moellers Hausschwammforschungen,* 1, 53—154.
6. FALK, R. (1908). Die Flugbrandarten des Getreides, ihre Vebreitung und Bekaempfung. *Journ. f. Landw.* 173—182.
7. FALK, R. (1909). Die Lenzitesfaeule des Coniferenholzes. *A. Moellers Hausschwammuntersuchungen,* vol. 3, XXXII, 1—234, 7 plates, 24 figs.
8. FALK, R. (1911). Ueber die Luftinfektion des Mutterkornes und die Verbreitung pflanzlicher Infektionskrankheiten durch Temperaturstroemungen. *Ztschr. f. Forst- und Jagdwesen* (Festschrift).
9. FALK, R. (1912). Die Meruliusfaeule des Bauholzes. *A. Moellers Hausschwammuntersuchungen,* vol. 6, XVI, 405 pp., 73 figs., 27 plates.
10. FALK, R. (1915). Ueber die Sporenverbreitung bei Morcheln und verwandten Pilzen. *Ztschr. f. Forst- und Jagdw.* 47, 407—421.

11. FALK, R. (1916). Ueber die Sporenverbreitung bei den Ascomyceten I. Die radiosensiblen Discomyceten. *R. Falks Mykologische Untersuchungen,* vol. I (2), 145 pp., 2 plates, 14 figs.

12. FALK, R. (1919). Ueber die Bewertung von Holz- und Pflanzenschutzmitteln im Laboratorium und ueber ein neues Spritzmittel fuer den Pflanzenschutz. *Angew. Botanik* 1, 177—185, 225—249.

13. FALK, R. (1920). Anweisung zur Kultur von Speisepilzen auf frischen Laubholzstubben. *Der Pilz- und Kraeuterfreund* 1, Heft 4/6.

14. FALK, R. (1923). Ueber die Sporenverbreitung bei den Ascomyceten II. Die taktiosensiblen Discomyceten. *R. Falks Mykologische Untersuchungen und Berichte,* vol. I (3), 18 figs.

15. FALK, R. und O. (1924). Ueber die Sporenkeimung des Champignons. *R. Falks mykologische Untersuchungen und Berichte,* Beihefte, 15 figs., 4 plates, 64 pp.

16. FALK, R. und van BEYMA THOE KINGMA. (1924). Methodisches und Prinzipielles zur Darstellung organischer Saeuren auf biologischem Wege mit Hilfe von Fadenpilzen. *Ber. Dtsch. Chem. Ges.* 57 (6), 915—920.

17. FALK, R. und KAPUR, S. N. (1924). Ueber Glukonsaeurebildung durch Fadenpilze. *Ber. Dtsch. Chem. Ges.* 57, 920.

18. FALK, R. (1925). Oskar Brefeld. *Bot. Archiv* II, 26 pp.

19. FALK, R. (1926). Ueber korrosive und destruktive Holzzersetzung und ihre biologische Bedeutung. *Ber. Dtsch. Bot. Ges.* 44, 652.

20. FALK, R. (1927). Sechs Merkblaetter zur Holzschutzfrage. *A. Moellers Hausschwammuntersuchungen* XII, 71.

21. FALK, R. (1927). Ueber die Groessen, Fallgeschwindigkeiten und Schwebewerte der Pilzsorten und ihre Gruppierung mit Bezug auf die zu ihrer Verbreitung noetigen Temperaturstroemungs-Geschwindigkeiten. *Ber. Dtsch. Bot. Ges.* 45, 262—281.

22. FALK, R. und HAAG, W. (1927). Der Lignin- und der Cellulose-Abbau des Holzes, zwei verschiedene Zersetzungsprozesse durch holzbewohnende Fadenpilze. *Ber. Dtsch. Chem. Ges.* 60 (1), 225—232, 3 graphs.

23. FALK, R. und COORDT, W. (1928). Der Methoxyl-Gehalt beim Lignin- und Cellulose-Abbau des Holzes. *Ber. Dtsch. Chem. Ges.* 61 B (9), 1201—1206.

24. FALK, R. und KEKTAR, V. (1934). Pruefung und Schutzwertbestimmung der Feuerschutzmittel des Holzes. *A. Moellers Hausschwammforschungen,* vol. 11, 5 figs, IV, 46 pp.

25. FALK, R. und O. (1937). Die Ptychogasterfaeule des Coniferenholzes. *A. Moellers Hausschwammforschungen.* vol. 12, S. 1—16, 47 figs. u. 3 plates.

26. FALK, R. (1937). Der chemische Holzschutz und seine handwerkliche Anwendung im Hochbau, bei laendlichen Bauten und fuer allgemeinere Nutzung im Freien. *A. Moeller, Hausschwammforschungen,* Heft 12, 110—130.

27. FALK, R. (1937). Gruppierung der Holzzersetzung und des Holzschutzes auf biologischer Grundlage. *Las Polski* No. 7/8.

JACOB JOSEPH TAUBENHAUS

1884—1937

By I. REICHERT

The death of J. J. TAUBENHAUS is a heavy loss to agricultural and plant-pathological science in general and to that of the United States in particular. To both the deceased devoted himself with great energy, outstanding ability, and true love. To us his death was the cause of even greater pain—such as parents feel when their beloved son falls on the battle-field, far away from them. J. J. TAUBENHAUS was born in Palestine and here he left father and mother. Never in the course of 37 years did his parents ,even for a day, give up hope again to embrace him and to marvel at the miraculous rise of their son, now so famous, who had left them as a boy with little prospects for his future. Deeply grieved, too, are his fellow-scientists in this our old-new country. We, who were destined to create the beginnings of agricultural and plant-pathological science in this small and forlorn corner between Asia and Africa, have always looked upon J. J. TAUBENHAUS as a brother living in far-off countries whose real place was with us here. Together with his family we have never ceased to hope that he may return and join in our work. Great was our pain when we lost him and we feel it imperative to tell of the work of this eminent personality and of his achievements during the short years of his life. For many of the biographical data of this article we are indebted to Mr. B. YOUNGBLOOD who published an obituary notice in Phytopathology, vol. 28, p. 525, 1938, and to the brother of the deceased, Mr. EPHRAIM TAUBENHAUS, who put at our disposal hitherto unknown details of his brother's childhood.

HIS YOUTH (1884—1900)

The town of Safed, where J. J. TAUBENHAUS was born on the 20th of October 1884, is situated on the slopes of one of the high mountains of Upper Galilee admidst scenery of great natural beauty.

In its neighbourhood, especially to the west, grow remnants of maquis forests and in the north Mount Hermon rises with its peak of everlasting snow of which the Psalmists have sung time and again in their hymns. In the South the Sea of Galilee wrapped in the mysteries of ancient times shines like a gigantic mirror sparkling in the sun. Josephus Flavius relates in his book on the war of the Jews against the Romans that the Jewish inhabitants of that part of the country were "Men of war who have never known any cowardice" and who protected their country from the enemies all around. All these heroes of Galilee and their descendants no longer exist. They were slain by the Romans, the Crusaders and finally by the Arabs. A small remnant which has never gone into diaspora has survived in a village near Safed called Pekiin. Safed itself was conquered by Arab invaders who imposed their reign of terror on the Jews remaining in the town. The Jewish community was small and was newly established in the 15th and 16th century, when refugees driven from Spain gathered there and founded a centre for the study of Mystics and Kabbalah. In their dreams of an early redemption they forgot their personal as well as their national disaster. Fear of the surrounding world, self-contained seclusion and religious piety which borders on hatred of all modern culture always characterized the Jewish Safed and still continues to do so. The Jewish citizens of this town found consolation in pious meditation for all the suffering with which they were afflicted there during the past centuries: the pogroms by the Arabs and the earth-quakes sent by God. To-day Safed is surrounded by many modern Jewish agricultural settlements. In 1884, the year of TAUBENHAUS' birth, Safed stood alone.

Its Jewish inhabitants lead a holy life. Except for a small number of artisans most of them had come from abroad in order to spend their time in religious worship and to dream of the Redemption of Man and Israel. The forefathers of TAUBENHAUS had settled in this country years ago, to serve God and to spend their lives in studying the Bible and in prayers for the Redemption of Israel. This was the environment into which young TAUBENHAUS was born. The greatest Rabbis and scholars of mystics in Safed stood by his cradle and prophesied to his parents that their son would one day excel in piety and knowledge of the Bible. When 3 years old he was placed under the care of a Rabbi who introduced him into the study of the

Holy Scripture and prayers. The boy made astonishing progress in his studies and when 7 years of age he already mastered much of the Bible and Talmud. All his teachers predicted a brillant future for him as a scholar of the Jewish faith and its teachings.

Young Taubenhaus was happy with the education and care afforded him by his parents. The Bible stories of the life of the Children of Israel in their homeland fascinated him. The mist of dreams and mystics spread over the town of Safed which gave its Jewish citizens the hope for Redemption inspired the boy. He frequently strolled about in Safed's beautiful surroundings visiting the villages and ruins which recall on every step what his people created in the past and how its heroes defended themselves against the Romans. The boy loved nature and often observed the shrubs and trees of gardens and the numerous plants of the fields around Safed. In his father's house he found material comfort as well as all the care he could wish for. His father was quite well off. He was the first to introduce into Safed mechanical weaver's looms and himself worked at one of them. In his spare time the boy observed and later also joined his father in his weaving-work. He really was very happy during this period.

But now something happened which completely revolutionized his life. On one of his strolls in the neigbourhood of Safed he came to the nearby Arab village of Djoni. This village had been bought by Baron Edouard Rothschild of Paris in 1882 in order to establish an agricultural settlement there under the name of Rosh Pinah. There young Taubenhaus saw Jews ploughing the soil, sowing, and planting vineyards and mulberry-trees in order to raise silk-worms. He was astounded to find Jews living in this way the like of which he had never previously seen in the town of Safed or the country around. When he spoke with the new peasants they told him that they had come to Palestine from Roumania in order to rebuild the ruins of the country and to help the Jewish people return to its soil and lead a natural life like all the other nations. This event aroused many new ideas in the boy. "So there is after all" he thought "a new road open to the Jew who adheres to the traditions of his forefathers and lives in Palestine—to build the country and to return to the soil". This thought continually ran through his mind but how was he to reach this magnificent goal, young as he was, a boy merely 8 years of age? Meanwhile he had heard from the peasants of Rosh Pinah that in Mikveh

Israel near Jaffa there was an agricultural school, founded by the Jews of France, where Jewish boys were trained to be farmers in this country. But all his entreaties that his father send him to Mikveh Israel were of no avail as he was still too young. Instead his father agreed to send him to the modern school conducted in the French language which was then being founded in Safed by the Alliance Israelite Universelle, of Paris. In this school TAUBENHAUS acquired the first elementary knowledge of science and natural history. Besides his studies he continued his walks in the country where he learned from nature and observed flowers and trees. On the roof of his parents' house (in Safed houses are flat-roofed and are built on a slope one above the other) he arranged a little garden and acquainted himself by his own experiments with the lives of various plants. His walks to Rosh Pinah became still more frequent and he learned how to sow and plant. In particular the breeding of silk worms aroused his interest. He took a few worms home and raised them. He observed their complex development from egg to pupa and recorded his observations in his note-book. This was the first work of TAUBENHAUS in experimental biology. He continued to go to this school for 4 years, and on October 27th 1897, upon the termination of his studies, his father agreed to fulfil his son's wish and to send him to the agricultural school of Mikveh Israel to be trained for a farmer's life in Palestine.

When TAUBENHAUS came to Mikweh Israel he was but 12 years of age. But his determination with regard to his future was that of a grown up. He knew what he meant to achieve in life—to link up with nature and to work the soil of his country. His dream now began to come true: he himself was now going to plough, and to sow, to plant trees, and to graft them. With enthusiasm and zeal he took up the hard work at this school which was not yet fully organized in all its branches. From morning to night he was busy with work in the fields or vineyards or in the classroom, where he listened to his teachers with a real thirst for knowledge. Three years of studies in this school passed by quickly enough and he made excellent progress. He graduated from the school with great distinction in October 1900.

ON THE CROSSROADS (1900)

It was only now after he had finished school in Mikveh Israel and after he had gained some experience in agriculture that an

element of uncertainty was introduced into the life of young TAUBENHAUS. He was already fifteen years of age, had received all the technical agricultural training possible in Palestine and had now to decide on his future: whether to return to the life of Safed, a purely spiritual life which had ceased to give him satisfaction, and in his opinion led neither him nor his brothers to a better life, or whether to engage in agricultural work at one of the colonies. The pact he had made in the mountains of Galilee with nature and with agriculture was never again to be dissolved, this he knew for certain. Mikveh Israel, however, instead of answering and satisfying him on all the questions and doubts regarding the cultivation of soil increased his indecision. On the one hand it confirmed the rightness of his decision and fixed his future walk of life for ever. On the other hand the more he had learned the more questions on nature and agriculture arose which his teachers could not answer. It was his fervent desire to devote himself to research and further to perfect himself. But how? In Palestine facilities for higher education were not available. The headmaster of Mikveh Israel, Mr. NIEGO, who thought highly of the abilities of his pupil TAUBENHAUS obtained for him a special scholarship. This was to enable him to go to Smyrna in Turkey and to visit the agricultural school "Or Yehuda" also founded by the Alliance Israelite Universelle in conjunction with the "Ica" (Jewish Colonis. Association), where a syllabus of agriculture more advanced than that of Mikveh Israel was being taught. At the time Mr. E. KRAUSE, to-day headmaster of Mikveh Israel, was in charge there. But how was TAUBENHAUS to get to Smyrna all by himself? An opportunity offered itself which solved this question. TAUBENHAUS' grandfather had to travel to Europe on behalf of the religous institutions of the Jewish community of Safed. It was decided, therefore, to send the boy with his grandfather through Constantinople to Smyrna. On his arrival in Constantinople, however, an event occured of momentous importance and deciding influence on the future course of his life. Through his grandfather he made the acquaintance of Rabbi CHAIM HERSHENSON and his family who were staying in Constantinople on their way to the United States. Rabbi HERSHENSON was an outstanding religious authority from Jerusalem. He was a great scholar of Jewish teaching and of broad general knowledge. He dreamt of God's redemption of the Jews which he believed would take place in the near future, and he believed that the Messiah's

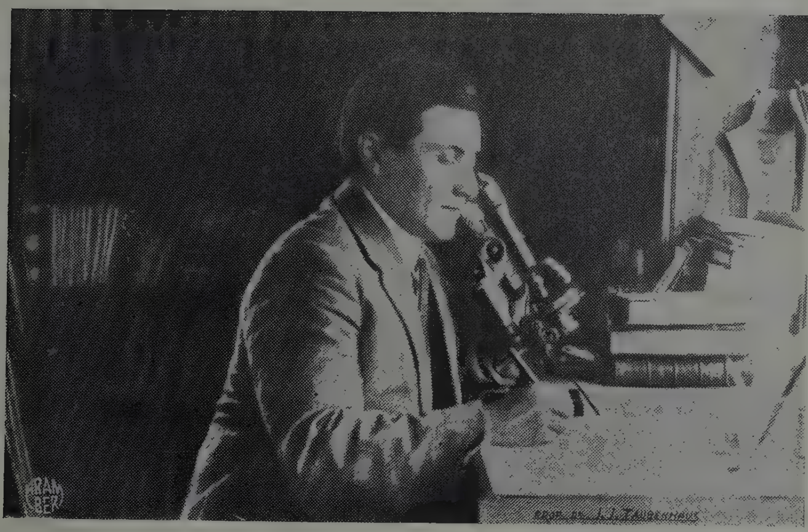
mission to return the Jewish people to the land of their fathers was imminent. The agricultural settlements of those days were to him the first indication of this. In his dream of Redemption he saw the Temple rebuilt, and the Jewish Kingdom re-established. He wrote whole books on the question how the life he then visualized would be conducted in conformity with the tradition of his forefathers. This dreamer left Jerusalem for the United States to call the Jews to come to Palestine and help build the country. In HERSHENSON's house young TAUBENHAUS met ESTHER HERSHENSON, the Rabbi's daughter who in the course of years became his wife. He was soon great friends with her, and confided to her his love of nature and agriculture and his determination to proceed with their study. She advised him to join her family on their voyage to America and to continue his studies there. Young TAUBENHAUS was delighted with this proposal and also obtained his grandfather's permission to go to the United States together with Rabbi HERSHENSON and his family.

ON THE THRESHOLD (1900—1909)

A new epoch—full of possibilities as well as difficulties—began in the life of TAUBENHAUS with the day of his coming to America in 1900, at the age of 16. The difficulties with which life confronted him multiplied all at once. Up to now he had had one aim in life—to learn agriculture—and all his efforts had been directed towards the achievement of this aim. But now the way to this goal was beset with serious obstacles. The first of them was the new civilisation of America, which placed him into a difficult position. Besides Hebrew he knew only French. He had to learn English quickly and to enter the spirit of the new culture in order to be able to commence his studies and to succeed with them. The second difficulty was psychological. The New World with its unlimited practical possibilities for a young man pounced on him with an enormous impact, ready to wrest from him his ideal of a life close to the soil. It tempted him with brilliant successes much easier of achievement if he were to enter other professions with better material prospects for him, who had come from abroad and was neither rooted in American soil nor linked to it by bonds of tradition. TAUBENHAUS overcame both obstacles at the same time. He learned the English language with astonishing rapidity and made up his mind not to entertain any ideas apt to lead him away from his aim in life and to

sever his connection with the soil. For this reason he declined the offer to study in preparation for college at a city school as he was afraid of becoming estranged from the country. And so he entered that well-known school for practical farmers, the National Farm School at Doylestown, Pennsylvania. Here he studied for 4 years. He finished the school in 1904. The basic agricultural education which Taubenhaus received at Doylestown left a lasting impression upon his life. He acquired there the fundamentals of agricultural theory and practice. All those questions which had arisen in the course of his studies at Mikveh Israel and which his teachers there had not been able to answer were now solved one by one. He worked hard and himself raised most plants of agricultural or horticultural interest. He came into intimate contact with the soil of America and succeeded in penetrating into the spiritual life of the country.

But with all his remarkable progress in practical agriculture Taubenhaus still felt the urge further to perfect his knowledge and he entered Cornell University, New York, in 1904. There he obtained the degree of B. Sc. in 1907 and the degree of M. Sc. in 1909. At Cornell University he worked very hard indeed. He had to earn his living by extra work in his spare time, partly by unskilled labour and partly by gardening. This, however, did not prevent him from delving deeply into advanced agricultural science and the necessary research methods. He took great interest in plant physiology and particularly, under the direction of his teacher the well-known plant pathologist Prof. H. H. Whetzel, in problems of plant diseases. During his studies he found the time to carry out experimental investigations into the influence of ether on the germination of seeds. At this university Taubenhaus became intimately connected with the agricultural science of America. Now he felt himself ready for the last decision on the career he was to choose for himself. Of one thing he was certain: he would remain in America and would continue his agricultural career there. For this purpose he became an American citizen in 1908. The great keenness and zeal he showed in his work soon attracted the attention of the lecturers and the principal of the college who saw in him a man destined to be a credit to agricultural science. Dean Liberty Hyde Bailey by means of a private loan enabled him to finish his studies, as the struggle for existence weighed heavily on young Taubenhaus. Throughout his life Taubenhaus remained grateful to his teacher for this help.



JACOB JOSEPH TAUBENHAUS

1884 — 1937

THE RISE (1909—1916)

His studies at Cornell University and especially the influence of Prof. WHETZEL determined TAUBENHAUS' future path. He discovered in himself the gift for independent research and endeavoured therefore to find work at one of the agricultural experiment stations. One of the great facilities offered by America is that agricultural scientists there have the opportunity to engage on practical scientific research work in well organized experimental stations. As mentioned previously TAUBENHAUS was attracted in particular by the subject of plant pathology. He succeeded in 1909 in finding work at the Experiment Station of Delaware as Assistant Plant Pathologist to the well known authority on plant diseases Dr. Melville T. COOK, who was at the time head of the division. In the same year he also enrolled at the University of Pennsylvania to work for the degree of Doctor of Philosophy in plant pathology. The principal of the Botanical Institute in Pennsylvania, Professor J. W. HARSHBERGER, gave him permission to do his work for the thesis at Delaware, where he was recently employed.

When he came to Delaware TAUBENHAUS in collaboration with Dr. Melville T. COOK embarked on fundamental research into those substances in plants which make them resistant to pathogenes. He spent more than 3 years at this work and obtained important results apt to throw much light upon the difficult problem of the disease resistance of plants. He found fruits to contain various enzymes, among them auxidase, the significance of which lies in their association with the disease resisting power of plants. Thus auxidase for example is found in fruits in great quantities at the beginning of the season, while later on it decreases. In addition fruits contain a certain other substance which has been defined as a poly-atomic phenol. If auxidase combines with this substance a compound similar to tannin is formed which has the power to kill fungi and other harmful organisms. This process of activation takes place in acid solution only. While fruits are unripe their acid content increases steadily and they contain great amounts of oxidase; their resistance to disease is therefore considerable. However, as fruits ripen and sweeten their power of resistance diminishes and they become increasingly susceptible to organisms causing rot (1, 2, 4). This work by TAUBENHAUS aroused widespread interest and as a result he was promoted to the

rank of Associate Plant Physiologist at the Delaware Experimental Station.

When he began his work at Delaware there was an outbreak of a serious wilt-disease of peas. Taubenhaus investigated this disease and found the pathogene to be a variety of the fungus *Gloeosporium*. For two years he made comprehensive studies of various strains of *Gloeosporium* which he isolated from 13 different plants affected by anthracnose. He found the *Gloeosporium* attacking peas to be identical with the *Gloeosporium* causing the bitter rot disease of apples. Conversely he found that the strains of *Gloeosporium* attacking the fruits of bananas and cucurbits cannot infect peas (3, 5). Apart from the interest he took in the wilt disease of peas he went on to make all other diseases of peas and the cultivation of the plant itself the subject of careful studies. He also wrote the thesis for his degree of doctor at Pennsylvania University on "The Diseases of Peas". In 1913 he obtained this degree. One year later he published a special bulletin on "Pea Diseases" at the Delaware experiment station (8). In the course of his work at Delaware he also wrote a comprehensive book of 256 pages on the cultivation of peas and on pea diseases which was published in 1917 (13). With the appearance of this book the research work of Taubenhaus on pea diseases reached its conclusion. He continued, however, to be interested in and to work on the plant diseases caused by various strains of *Gloeosporium*, and he was regarded as one of the greatest experts on these diseases.

During his work at Delaware Taubenhaus devoted a great part of his time to investigations of the diseases of sweet potatoes. Immediately on his arrival at Delaware Station he came across the Black Rot of sweet potatoes which was first described by Halsted and was attributed by him to the fungus *Sphaeronema fimbriatum*. Taubenhaus studied this disease intensively and showed not this, but another fungus *Sclerotium bataticola* to be the cause of the rot (6). The discovery of this fungus became important in the course of time as it was found to cause numerous root rots in tropical and subtropical countries of the Old World. There the name of the fungus was changed by Butler to *Rhizoctonia bataticola* but Henson and Valleau in their last research (Phytopathology Vol. 27, p. 913, 1937) are right in maintaining the first name given by Taubenhaus.

On this and other diseases attacking sweet potatoes TAUBENHAUS still wrote various other papers at Delaware, two of which deserve special mention: One paper published in 1914 gave entirely new details of the *Sclerotium bataticola* rot and distinguished the type of wilt which it causes from other wilt diseases occurring on sweet potatoes (7). Special mention must be made of his second paper, a comparative study of the Black Rot caused by the fungus *Lasiodiplodia tubericola* (10). This work is important not so much because of the research into the disease itself but because of its significance to systematic botany. TAUBENHAUS discovered the interesting fact that three different species of fungi like *Chaetodiplodia, Botryodiplodia* and *Diplodiella* known to cause various rots could produce the same type of black rot of sweet potatoes and developed in the tubers in the same way as *Lasiodiplodia tubericola.* The conclusion he drew from this was that three of the species of fungi mentioned were to be abandoned and that only the name *Diplodia* was to be retained by the right of priority. These findings are still of practical application to-day as unfortunately wrong conceptions regarding these species even now persist among plant pathologists. TAUBENHAUS soon became known throughout America as the greatest authority on diseases of the sweet potato and he was invited in 1916 to give the John Lewis Russell Lecture, in the Massachusetts State Horticultural Society, on Sweet Potato Diseases and their Control (11).

In the same year, 1916, he published a paper on the white potato which made him famous. He found that the potato disease Silver Scurf was not caused by the fungus *Phellomyces sclerotiophorus* as was believed at the time, but by *Spondylocladium atrovirens,* and that *Phellomyces* was merely a secondary invader. He also showed *Phellomyces* itself to be identical with another fungus which appeared in literature under two different names. In this and the second paper on *Diplodia* TAUBENHAUS showed an intimate knowledge of systematic mycology such as is not commonly found even among the most experienced plant pathologists.

AT THE GOAL (1916—1937)

The important work published by TAUBENHAUS at Delaware paved his way to a higher position. In 1916 he was appointed head of the Division of Physiology and Plant Pathology at the Agricultural

Experiment Station of Texas, which post he retained until his death. During his twenty years in Texas he acquired his great fame. There he published a great deal of research on plant diseases which placed him in the first rank of American plant pathologists. On the subject of cotton diseases he became the world's greatest authority.

In the first years of his work at Texas he continued to investigate the diseases of sweet potatoes which are grown in the state of Texas on a large scale. Of the studies on sweet potato diseases he carried out there two were outstanding: The one on the pox disease (14), and the second on the rot caused by *Sclerotium Rolfsii* (19). In his detailed investigation published in 1918 TAUBENHAUS definitely proved the Pox disease to be caused by the myxomycete *Cytospora batata,* and not by the fungus *Acrocystis batatis* as had previously been assumed. He also investigated the ecological conditions under which this disease occurs. In the second paper which appeared in 1919 TAUBENHAUS examined the mode of infection of *Sclerotium Rolfsii* on sweet potatoes and other plants. He gave, for the first time, an accurate morphological description—still of great value to-day—of this important fungus. In 1919 he also reviewed all his work on the diseases of sweet potatoes in two bulletins published by the Agricultural Experiment Station of Texas (17, 18). Later, in 1923, he published a big book on the culture and diseases of the sweet potato (26). This work concluded his research on diseases of sweet potatoes.

During his first years at Texas TAUBENHAUS also did important experimental work on the wilt diseases of various plants such as cucurbits (21), spinach (28) and onions (16, 24). He succeeded in isolating the pathogenes and found them all to belong to various new species of the genus *Fusarium.* He studied the biology of these fungi as well as the conditions of their occurrence and also discovered means for their control. His special interest was aroused by diseases of onions on which he wrote a bulletin in 1912 and a text-book in 1924 (27).

TAUBENHAUS further published several papers on diseases of cereals, especially of summer cereals (22, 23). Important is his study of the black and the yellow moulds of ear corn in which he gives a detailed description of these diseases which are caused by a fungus with the help of an insect.

The first period of Taubenhaus' work at Texas was extraordinarily fruitful. In 1918 he wrote a book of 427 pages on vegetable diseases (15) and in 1920 he wrote another book of 444 pages on "Diseases of greenhouse crops and their control (20). These two books were written in popular language and were meant for practical farmers and vegetable growers but they are nevertheless extremely useful to plant pathologists and scientists, too. Professor E. A. Bessey rightly says in his review of the first book: "This book will be appreciated by experiment station workers, extension specialists, and college students as well as by the truck growers . . ."

All this important work which he accomplished when he first came to Texas would in itself have been enough to be the life-work of a plant pathologist and to earn him renown. But it can only be regarded as secondary to the main research carried out by Taubenhaus in his lifetime: his work on the cotton plant and more particularly on its most destructive root rot caused by the fungus *Phymatotrichum omnivorum*. This root rot is the limiting factor in the cotton cultivation of Texas and causes huge losses to the cotton growers of the state. Up to 100 million dollars damage is done every year. The fungus attains special importance because it attacks most other economic plants as well and is therefore extremely difficult to control.

Immediately after he had come to Texas Taubenhaus began to investigate this dangerous disease and six years passed before he was able to sum up the first results of his research in a bulletin of 100 pages published by the Texas Agricultural Experiment Station in 1923 (25). From this and other papers which appeared in the course of twenty years in such numbers that we cannot mention them all for lack of space and because we could not lay our hands on all of them, we may judge how great and varied was the work of Taubenhaus and his approach to this difficult problem.

He first discovered that the disease was not carried by wind—as plant pathologists generally believed—but spread underground by means of root contact. His second discovery was the fact that the fungus thrives on living roots only and not on dead plant matter. Thus new ways of controlling the disease became feasible: the only requirement was to plough the soil deeply and to bury all plant resi-

dues. Thirdly, he discovered that no monocotyledonous plant is attacked by the disease while it affects almost all dicotyledonous plants. It can hardly be imagined what a tremendous amount of work TAUBENHAUS had to do before he could establish this fact. During twenty years he carried out continuous experiments on this question. He raised plants on special experimental plots, infected them with the causal organism and studied the results of these infections to see whether the plants became affected or remained immune to the disease. In the course of these twenty years he examined more than 2116 species of plants belonging to 131 families. Of these he found 408 to be immune to the disease, 403 to be resistant, and 1305 to be susceptible. Besides the Monocotyledons, which are immune, the Crucifers and Cucurbits showed signs of resistance (31, 37). The importance of these findings for the control of the disease are obvious: Every farmer was now in a position to know which plants he had to avoid and to eradicate from his fields because they might transmit the disease, and which plants he could use in crop rotation. In order to protect the fields from the disease TAUBENHAUS showed that barriers. of sorghum or maize for example, could check its spread (31, 32).

Of great importance, too, was the research of TAUBENHAUS on the fungus itself. He studied its morphology and biology and discovered all its methods of propagation by means of conidia and sclerotia. The latter are of great significance in the spread of the disease as they can persist in the soil for three years even after the hosts have died, and thus enable the fungus to survive (35). The danger of contamination remains, therefore, for three years on fields where cotton has once been grown. TAUBENHAUS investigated the influence of acidity and alkalinity on the development of the fungus and discovered that it does not occur on acid soils, and that it cannot develop on soils with a pH value of 4.1 or less, while in cultures growth is only stopped at a pH value of 3.0 (29, 30). These findings made TAUBENHAUS attempt the creation of barriers of soil made acid by the addition of quantities of sulphur. These were to serve as chemical barriers against the spreading of the disease in the same way as sorghum prevents its spreading and serves as a living barrier. He also carried out numerous experiments on soil disinfection by means of various fungicides, in order to kill the pathogene.

This work has not yet been completed (34). Recently TAUBENHAUS also began to study the physiology of cotton attacked by the root rot disease. One of his discoveries which is of general interest is that the leaves of diseased plants have a temperature higher than that of the air about them, while healthy plants have a temperature lower than that of the air (33).

Numerous and manifold are the works of TAUBENHAUS on the diseases of other single plants, and it would be difficult to mention all of them here. YOUNGBLOOD in his article referred to above gives a list of the majority of these publications. The work on diseases of the rose which he began shortly before his death may be mentioned (36) He meant to write a special book on the subject but apparently did not live to accomplish this task. Likewise he does not seem to have completed two other books which E. P. Dutton, the publisher of TAUBENHAUS' works, mentions in his prospectus. These two books were to be: "Applied Economic Microbiology" and "The Soil in Health and Disease".

Death came and took him from us in the middle of his work, with his ultimate aim almost within reach. Death cruelly destroyed all his dreams and plans which he was gradually realizing. At his death, on December 13, 1937, he was only 53 years of age. What might he not yet have given to agricultural science!

TAUBENHAUS AND HIS WORK

One feels puzzled in surveying the enormous amount of work accomplished by TAUBENHAUS in his life-time. In 25 years of scientific research he was the author of more than 100 publications, including five big books. His fruitfulness increased greatly after he had come to Texas in 1916. It is interesting to note that for many years, apparently until 1928, he worked in his laboratory without a scientific assistant; and it was just in those years that his output of work was most extraordinary. YOUNGBLOOD who was for many years Director of the Texas Experiment Station and knew TAUBENHAUS intimately writes of him: "For some years after going to the Texas Station he did pioneer work in arousing interest in disease control. He identified diseases and made recommendations for control to the Extension Service. and identified the causes of loss in transit for the railroads. Despite these services he carried on extensive investigations . . ."

And just at that time his writings were prolific and he published many individual researches and summarising bulletins. He wrote all his five books between 1917 and 1924. In addition he was very thorough in what he began and endeavoured always to get at the root of the problems he investigated. He himself relates that he made thousands of cultures of each pathogene before he succeeded in clarifying all sides of the problems. Such quantities of work are difficult to comprehend and were only possible because he continually overworked himself. Youngblood tells us that he worked incessantly and only very seldom took a holiday from his work. He writes: "Some who knew him intimately feel that too long and continuous application to his work may have hastened his death." So devoted was Taubenhaus to science that he failed to look after his own health.

Taubenhaus occupied one of the foremost ranks among the plant pathologists of the United States. He was the greatest authority on cotton diseases, especially on *Phymatotrichum* root rot, and was also chairman of this section of the Cotton Disease Council for the whole of America. He was regarded as one of the best experts on *Gloeosporium* and *Fusarium* Wilts of plants. He also showed himself of outstanding ability in his taxonomic and morphological studies of fungi, a trait lacking frequently even among good plant pathologists. He was the first man in plant pathological world literature to write textbooks on vegetable diseases and on the diseases of several individual plants. The important books by Chupp on vegetables and by Fawcett on citrus only appeared after his works. Taubenhaus thus did pioneer work in this respect.

As a man Taubenhaus was of strong character, faithful to himself and others. Without this it would be difficult to picture his career. He never forgot the friends and teachers who had once helped him. Nor did he forget the school at Doylestown where he had imbibed the fundamentals of agriculture as well as of American culture. He worked on its behalf throughout all the years. Youngblood relates that the school recognized his eminent qualities, elected him to be the principal speaker at the banquet given in New York City for its benefit and also appointed him Director for the state of Texas.

Taubenhaus also was a good speaker and lecturer. He frequently spoke on the wireless of Texas and in agricultural assem-

blies on problems of the cultivation and diseases of plants. The farmers of Texas had in him a faithful guide full of understanding for their needs. It is significant that three of his books contained big sections on the general cultivation of the plants in question. Similarly the students of Texas Agricultural College found in him a good friend who always had their well-being at heart. He never forgot how important the help of his teachers had been for him. In 1924 he became a Member of the Graduate Faculty of the College and thus acquired direct influence on student affairs.

TAUBENHAUS was highly estimated by his collaborators as a good and loyal colleague. As mentioned before he worked without an assistant until 1928, but he closely collaborated with other divisions and services of the Texas Agricultural Experiment Station. His first great work on cotton in 1923 was published in cooperation with Mr. T. KILLOUGH; his text-book on onions was written in collaboration with Mr. F. W. MALLY, both of the Texas Station. His later work was marked by cordial co-operation with the assistants of his laboratory, of whom Dr. WALTER N. EZEKIEL must be mentioned in particular. In him TAUBENHAUS found a faithful collaborator and only with his help could the great work on cotton root rot be accomplished.

TAUBENHAUS had a happy family life with his wife, Esther Hershenson, whom he had met in Constantinople at the crossroads of his life, and who helped him to find his way into the first rank of American agricultural science. He married her in 1910 and they had two children, a son and a daughter.

TAUBENHAUS never lost his connection with Palestine and took an interest in the agricultural revival of the country and the return of the Jews to their land and soil. Above all he constantly longed for a reunion with his father and mother who had waited for his coming for 37 years. He loved them dearly and wrote to them often. However, his scientific work and the heavy responsibilities he had to carry, which did not permit him to interrupt his work even for a holiday, did not allow him the leisure to realize his desire. So he died young and far away from the mystery-wrapt mountains of Galilee that had inspired him in his childhood.

SELECTED PUBLICATIONS BY TAUBENHAUS MENTIONED IN THIS ARTICLE

1. COOK, M. T., BASSETT, H. P., THOMPSON, F. and TAUBENHAUS, J. J. (1911). Protective Enzymes. *Science* (n. s.) 33:624—629.
2. COOK, M. T. and TAUBENHAUS, J. J. (1911). The relation of parasitic fungi to the contents of the cells of host plants (I. The toxicity of tannin). *Del. Agr. Exp. Sta. Bul.* 91.
3. TAUBENHAUS, J. J. (1911). A study of some Gloeosporiums and their relation to a sweet pea disease. *Phytopath.* 1:196—202.
4. COOK, M. T. and TAUBENHAUS, J. J. (1912). The relation of parasitic fungi to the contents of the cells of host plants (II. The toxicity of vegetable acids and the oxidizing enzymes). *Del. Agr. Exp. Sta. Bul.* 97.
5. TAUBENHAUS, J. J.(1912). A further study of some Gloeosporiums and their relation to a sweet pea disease. *Phytopath.* 2:153—160.
6. TAUBENHAUS, J. J.(1913). The black rots of the sweet potato. *Phytopath.* 3:159—166.
7. TAUBENHAUS, J. J. (1914). Recent studies of some new or little known diseases of the sweet potato. *Phytopath.* 4:306—320.
8. TAUBENHAUS, J. J. (1914). The diseases of the sweet pea. *Del. Agr. Exp. Sta. Bul.* 93.
9. TAUBENHAUS, J. J. and MANNS, T. F. (1915). The diseases of the sweet potato and their control. *Del. Agr. Exp. Sta. Bul.* 109.
10. TAUBENHAUS, J. J. (1915). The probable non-validity of the genera Botryodiplodia, Diplodiella, Chaetodiplodia and Lasiodiplodia. *Amer. Jour. Bot.* 2:324—331.
11. TAUBENHAUS, J. J. (1916). Sweet Potato diseases and their control (The John Lewis Russell Lecture). *Trans. Mass. Hort. Soc.* 1:131—143.
12. TAUBENHAUS, J. J. (1916). A contribution to our knowledge of silver scurf (Spondylocladium atrovirens Harz) of the white potato. *Mem. New York Bot. Gard.* 6:549—560.
13. TAUBENHAUS, J. J. (1917). The culture and diseases of the sweet pea. E. P. Dutton Co., New York.
14. TAUBENHAUS, J. J. (1918). Pox or pit (soilrot) of the sweet potato. *Jour. Agr. Res.* (U.S.) 13:437—450.
15. TAUBENHAUS, J. J. (1918). Diseases of truck crops and their control. E. P. Dutton Co., New York.
16. TAUBENHAUS, J. J. (1919). Pink root of onions. *Science* (n. s) 49:217—218.
17. TAUBENHAUS, J. J. (1919). Field diseases of the sweet potato in Texas. *Texas Agr. Exp. Sta. Bul.* 249.
18. TAUBENHAUS, J. J. (1919). Storage and diseases of the sweet potato in Texas. *Texas Agr. Exp. Sta. Bul.* 250.

19. TAUBENHAUS, J. J. (1919). Recent studies on Sclerotium Rolfsii Sacc. *Jour. Agr. Res.* (U.S.) 18:127—138.

20. TAUBENHAUS, J. J. (1920). Diseases of green house crops and their control. E. P. Dutton Co., New York.

21. TAUBENHAUS, J. J. (1920). Wilts of the watermelon and related crops (Fusarium wilts of cucurbits). *Texas Agr. Exp. Sta. Bul.* 260.

22. TAUBENHAUS, J. J. (1920). Diseases of grains, sorghums, and millet, and their control in Texas. *Texas Agr. Exp. Sta. Bul.* 261.

23. TAUBENHAUS, J. J. (1920). A study of the black and yellow molds of ear corn. *Texas Agr. Exp. Sta. Bul.* 270.

24. TAUBENHAUS, J. J. and MALLY, F. W. (1921). Pink root disease of onions and its control in Texas. *Texas Agr. Exp. Sta. Bul.* 273.

25. TAUBENHAUS, J. J. and KILLOUGH, D. T. (1923). Texas root rot of cotton and methods of its control. *Texas Agr. Exp. Sta. Bul.* 307.

26. TAUBENHAUS, J. J. (1923). The culture and diseases of the sweet potato. E. P. Dutton Co., New York.

27. TAUBENHAUS, J. J. and MALLY, F. W. (1924). The culture and diseases of the onion. E. P. Dutton Co., New York.

28. TAUBENHAUS, J. J. (1926). Studies of a new Fusarium wilt of spinach in Texas. *Texas Agr. Exp. Sta. Bul.* 343.

29. TAUBENHAUS, J. J., EZEKIEL, W. N. and KILLOUGH, D. T. (1928). Relation of cotton root rot and Fusarium wilt to the acidity and alkalinity of the soil. *Texas Agr. Exp. Sta. Bul.* 389.

30. EZEKIEL, W. N., TAUBENHAUS, J. J. and CARLYLE, E. C. (1930). Soil reaction effects on Phymatotrichum root rot. *Phytopath.* 20:803—815.

31. TAUBENHAUS, J. J. and EZEKIEL, W. N. (1931). Cotton root rot and its control. *Texas Agr. Exp. Sta. Bul.* 423.

32. TAUBENHAUS, J. J. and EZEKIEL, W. N. (1932). Sulphur barriers and graminaceous crop barriers to prevent spread of Phymatotrichum root rot. *Phytopath.* 22:26.

33. EZEKIEL, W. N. and TAUBENHAUS, J. J. (1932). Leaf temperatures of cotton plants with Phymatotrichum root rot. *Science* (n. s.) 75:391—392.

34. EZEKIEL, W. N. and TAUBENHAUS, J. J. (1934). Comparing soil fungicides with special reference to Phymatotrichum root rot. *Science* (n. s.) 79: 595—596.

35. TAUBENHAUS, J. J. and EZEKIEL, W. N. (1936). Longevity of sclerotia of Phymatotrichum omnivorum in moist soil in the laboratory. *Amer. Journ. Bot.* 23:10—12.

36. TAUBENHAUS, J. J. and BOYD, G. T. (1936). Preliminary report on Diplodia die-back of roses. *American Rose Annual* 21:127—129.

37. TAUBENHAUS, J. J. and EZEKIEL, W. N. (1936). A rating of plants with reference to their relative resistance or susceptibility to Phymatotrichum root rot. *Texas Agr. Exp. Sta. Bul.* 527.

יעקב יוסף טובנהוז ז"ל

מאת י. ריכרט

י. י. טובנהויז נולד בצפת בשנת 1884 ונפטר בשנת 1937. למד במקוה־ישראל ונסע אח"כ דרך קושטה לארצות הברית בשנת 1900. למד שמה ארבע שנים בביה"ס חקלאי בדויליסטון וב־1904 נכנס לאוניברסיתה ע"ש קורנל וגמר את למודיו בשנת 1907. בשנת 1909 קבל משרת עוזר פיתופתולוגי בתחנת הנסיון בדליבר ושהה שם עד 1916. באותה שנה נקרא לנהל את המחלקה לפתולוגיה בתחנת הנסיון אשר בטקסס ונשאר שמה עד יום מותו.

עבודתו היתה פוריה עד מאד. עבד על האנזימים העוזרים לצמחים להתגונן מפטריות התוקפות אתם. חקר באופן מקורי את מחלות האפונה, הבטטה המתוקה והבצלים וכתב עליהם ספרים שלמים. הוא הגדיל לעשות בחקירותיו את מחלות הכתנה, ביחוד מחלת רקבון השרשים הנגרמת ע"י Phymatotrichum omnivorum. הוא מצא דרכים איך להלחם במחלה הנוראה הזו המשמידה בכל שנה רכוש של מאה מיליון דולר. כתב ספרים גדולים על מחלות ירקות וצמחי החממות. תכניותיו היו רבות ונפסקו באמצע ע"י מותו המוקדם. זכרו יהיה ברוך לעד.

לזכרו של הנס מוליש

מאת ה. ר. אופנהיימר

פרופ׳ הנס מוליש (1856 — 1938) היה ידוע לקהל הרחב כמחבר הספר „פיזיולוגיה של הצמח כתורת הגננות״. נולד כבן לגנן בברין (מורביה), עיר שהורה בה לפנים גריגור מֶנדֶל. הוא חִבֵּר 21 ספר ו-200 מאמרים במקצועות האנטומיה ופיזיולוגיה של הצמח ובבקטריולוגיה. עשה גדולות בהיסטוכימיה של הצמח. נושאי-מחקר שהצטיין בהם היו, בין יתר הדברים: תפקיד הברזל בחליפת החומרים, השפעת הכפור והחום על התא, התכונות הכימיות של הכלורופיל וחמרי-צבע הדומים לו או המלוים אותו באָצוֹת, צנורות החלב בצמחים ותפקידם. הוא חקר את שאלת הגורמים החיצוניים העלולים לעורר צמחים ממצב תרדמה והמציא למטרה זו את שיטת הטבילה במים פושרים. תשומת-לב מיוחדת הקדיש לחליפת החומרים של הבקטריות האוגרות גפרית וברזל בתאיהן. חקירותיו על יצירת אור ע״י בקטריות ופטריות הניחו את היסודות לידיעתנו על תופעה זו הקשורה בתהליך הנשימה.

ריכרד פלק

(ליום הולדתו הששים וחמש)

מאת י. ריכרט

נמלאו 65 שנה לחוקר הפטריות הידוע ריכרד פַלק.

הוא היה תלמידו של אוסקר ברפלד, הקלסיקון של המיקולוגיה הגרמנית. הוא נתקבל אצלו כעוזר במעבדה שלו בברסלו בשנת 1902 ועבד עמו יחד על גלוי אפן התפתחותו של הפֶחמוֹן הפורח של חיטה, שלא היה ידוע עד אז. אח״כ הוטל עליו מטעם המיניסטריון הפרוסי לחקר את נגע הבית הנגרם ע״י Merulius lacrimans. פלק עשה גדולות בחקירת המחלה הזו. המחקר הזה התפשט על כל הפטריות הגורמות לרקבון עצי בנין ועצי יער. הוא חקר את הצורות השונות של הפטריות האלה ואפני חייהם האקולוגיים. הוא נתמנה בשנת 1910 לפרופסור למיקולוגיה בביה״ס הגבוה ליערות במונדן. נהרו אליו תלמידים מכל קצות העולם והתפרסם עד מאד במחקריו שפרסם בעתון מיוחד שהוציא בעצמו ובעתון שני שעבר לידו אחרי מות אלפרד מֶלָר. כתב מונוגרפיות רבות על פטריות שונות: הידועות ביותר הן המונוגרפיות על Merulius ועל Lencites. הוא פוטר ממשרתו בעקב חוקי הגזע ע״י ממשלת גרמניה.

היה בארץ ולא מצא עבודה. נקרא ע״י ממשלת פולין לנהל את החקירות הפתולוגיות על מחלות היערות בפולין. הננו מברכים אותו ואותנו שיזכה לשוב לארץ, כדי להמשיך פה את העבודה.

דומות ברקבון שהן מחוללות ובצורתן המורפולוגית. בפטרית הדוטיורלה של תפוח-הזהב נתקבלה הצורה השלמה (הפרתציות-הסחַרְתִיקים) רק בתרבות.

נתנו סקירה על מחלות צמחים אחרים, הנגרמות ע״י פטריה דוטיורֶלה הדומה לשלנו. כל פטריות הדוטיורלה האלה, בצורתן הפיקנידיָלית, דומות בהרבה לפטריה .Dothiorella gregaria Sacc, ובצורתם השלמה ל-Botryosphaeria. ribis S. and D. הצורה השלמה (בוטריוספריה) שנמצאה בא״י שונה מזו של אמריקה רק בזה שהיא אינה מאדימה את קרקעות המזון המכילות עמילן.

על מקרה של התחדשות חוד־צמיחתו של הנצר מתוך ההיפוקוטיל

מאת ק. מ נ ד ל

כיוון שיצירה חדשה של נצרים מתוך צמחי־נביטה ערופים היא חזיון יקר־מציאות, לא למותר הוא להודיע על כל מקרה כזה. הורצה כאן על מקרה, שאצל אנונה שבלולית (Annona muricata), שנקטמו לה הפסיגים עם חוד־הצמיחה של הנצר, חזר ההיפוקוטיל והצמיח נצר מחדש. בקצה העליון של גודמת ההיפוקוטיל נתהווה מספר גדול של גבשושיות הדומות לנטפים, ובמשך זמן קצר (8—10 ימים) נפלגו אלה לפקעים. הפקע הראשון התחיל אחרי 8 ימים את הצמיחה ו־3 שבועות אחרי הקטימה כבר התנוסס ענף קטן בעל שלשה עלים נורמליים. כל שאר הפקעים הפסיקו את התפתחותם וצמקו. זהו המקרה הראשון של חידוש צמיחה לנצר מתוך ההיפוקוטיל הקטום של צמח עֵצִי.

החזזית Physcia Biziana על ארזי הלבנון

מאת י. ר י כ ר ט

החזזית Physcia Biziana נמצאה עד עכשו בדַלמַציָה ועכשו נמצאה על הלבנון. מסולונגו היה הראשון שתארה ונתן לה השם Squamaria. בתכונה האמיתית הכיר צהלברוקנר בשנת 1901. סמניה המובהקים הם: קמח לבן על היַצַע (thallus) והצטהבות הקלפה העליונה של היַצַע בתמיסת KOH.

מצאנו את החזזית גם בארצות ים התיכון אחרות: מרוקו, איטליה וקורפו. את החומר מצאנו בעשביות שונות תחת שם אחר. היא נמצאה על ידינו גם בארץ-ישראל בגליל העליון על זיתים בקרבת הכפר רמה. החזזית מתפתחת כנראה בעיקר במקומות גבוהים ורטובים, כך הדבר בדלמציה, מרוקו, קורפו וכך גם בלבנון ובא״י. היא יכולה איפוא, להחשב, כאלמנט מדיטרני-אטלנטי-הררי.

נסיונות בעצירת האלביניות בנביטי ההדר

מאת י. פרלברגר וי. ריכרט

החקירה הראתה שהנזק הנגרם לנביטי הדר ע״י מחלת האלביניזם, ז. א. שהעלים נשארים לבנים משוללי כלורופיל, הוא גדול והוא מגיע לפעמים עד כדי 74% של הנביטים.

אפשר לעצור לגמרי את נזק האלביניות בנביטים או לכל הפחות להפחיתה, ע״י טבילה מוקדמת של הזרעים בתמיסות של אוספולון, צֶרְזַן וגרמיזַן או ע״י אבוק באָבָוויט. חטוא האדמה באותם החמרים לא הועיל בכלום. נסיונות שהתכוונו לברר את השפעת תנאי הסביבה על תופעת האלביניות לא נתנו תוצאות חיוביות.

נסיונות במעבדה גילו שאפשר לעצר את האלביניות גם ע״י טבילת הזרעים בתמיסות של כספית, נחושת, עפרת, קובלט וניקל. כלפי זה לא הראו מלחי ברזל, צינק (בדיל), מנגן, מגנזיום, קלציום (שידן), סטרונציום ובריום שום תוצאות חיוביות.

יש לבאר את תופעת האלביניות בנביטי הדר כתכונה העוברת בירושה בצמח, המתגלה רק בשעת הנביטה. יש ליחס את התופעה להפרעה במערכת האנצימים של הצמח בתקופה זו. באור זה מקבל תוקף ע״י העובדה שמתכות כבדות, הידועות כמשפיעות על מערכת האנצימים, יכולות למנוע את הופעת האלביניות.

רקבון פירות הבננה ותפוח־הזהב ע״י דוטיורֶלָה

מאת י. ריכרט ואסתר הלינגר

פרסמנו ידיעות על הופעה ראשונה של רקבון בפירות בננה הנגרם ע״י הפטריה דוטיורלה. הרקבון מתגלה בפיטם הפרי ומתפשט כלפי העקץ. סימנו המובהק של הרקבון הוא האבק הלבן הנראה על החלקים הרקובים.

אפיה הטפילי של הפטריה הוכח ע״י נסיונות הדבקה. הצורה הפיקנידיָלית (הצורה שבה מופיעים רק המכלָאים — הפיקנידיות) הופיעה על הפירות אבל לא בתרבויות.

נראה שהופעת המחלה תלויה בעיקר בתנאי הרטיבות ופחות בתנאי החֹם, כי היא מצויה בעיקר בחדשים הרטובים של החורף, בשעה שהפטריה מתפתחת בכל מיני הטמפרטורות — נמוכה וגבוהה. נסיונות הדבקה של שתי יערב על פירות בננה ותפוח-זהב בפטריות הדוטיורלה שהופרדו מבננה ותפוח-זהב הראו שהן

מעזבון אהרנסון III:
להכרת הצומח של הבוספורוס

מאת מ. אבנארי וה. ר. אופנהיימר

בחדשים מאי־יולי 1908 שהה אהרן אהרנסון בסטמבול, במקום שהוטל עליו, על פרופ׳ בלאנקנהורן ועל ד״ר י. אהרני לכונן בית־נכאת לטבע לשולטן. בהזדמנות זו יצא אהרנסון לטיולים אל סביבות הבוספורוס ואסף מעשב של צמחי המקום. במות החוקר, ב־1919, נשאר המעשב הזה מוגדר רק מקצתו. רשימת הצמחים המתפרסמת בזה, הכוללת את אוספי אהרנסון משני חופי הבוספורוס, ראויה עכשיו לתשומת לב יתרה, מפני שד״ר ב. ו. ד. פוסט בסטמבול עסוק כעת בהכנת פלורה מצויירת של נוף הבוספורוס. הרשימה מביאה צמחים אחדים חדשים לגבי הבוספורוס.

על הצומח של ביצות החולה

מאת ה. ר. אופנהיימר

החלק הפנימי של ביצות החולה, הסמוך לים סומכי ולירדן, נחקר מן הבחינה הבוטנית רק מעט. את חברת־הצומח הראשית של החבל מהווה Papyreto-Polygonetum, שלמיניו הנגידים נלווית „אברת־הנשר״ (Pteridium aquilinum). יש מקומות שאין פוגשים בהם אלא גומא הפפירוס (Cyperus Papyrus), „הרבברך המחודד״ (Polygonum acuminatum) ו־Pteridium, בלבד. חוץ מחברה זו מרובה כניכר, ערכה של חברת „מרבדן־הביצות״ (Cladietum Marisci), בעוד שקנה־הסוף וה„חשיפה המצויה״ נמצאו כפחותי־ערך במקומות המסויירים של ביצת־קנים טיפוסית זו. הגומא שנקצץ חוזר לגידולו במקומות שגבוהה בהם רמת המיב, ואילו המקומות שאינם רוויי מים כל כך — בהם נמצאה ניבת־ירשה*) של צמחים תאבי־ מים פחות קצת מן הגומא; ביניהם חלק חשוב ל„שנית הגדולה״ (Lythrum Salicaria). על שפת הירדן נמצאו ערבי־נחל ו־Cyperaceae שונים, ממיני הגומא, העליעב (Fimbristylis) וכו׳. מן הבחינה הגיאוגרפית־צמחית יש לדון את הצומח האמור כתערובת של צמחי מים מתוקים, — טרופיים, צפוניים וכמעט קוסמופוליטיים. חברות־הצמחים השליטות מצטיינות בדלות של מינים, בהקבל לתנאי־החיים הקיצוניים.

*) ניבת־ירשה — Sukzessionsflora

אוטו ורבורג ז״ל

מאת י. ריכרט

אוטו ורבורג נולד בשנת 1859 ונפטר בשנת 1938. התפרסם בעבודתו הפיתוגאוגרפית על גוינאה החדשה והאיים הקרובים לה. לשם כך נסע למזרח הרחוק ובילה שם בנסיעות ואסף חמרים במשך ארבע שנים. הוא גילה שצומח האי גוינאה אינו דומה לצומח של אוסטרליה כמו שחשבו אז החוקרים אלא מהוה חטיבה עצמית שיש לה קרבה יתרה לחלק המזרחי של איי מלאיה. הוא קרא לחלק עולם זה ולצומח שבו פַּפּוּאַסִיָה.

ורבורג פרסם מחקרים רבים, ביניהם רשמים ועבוד החומר אשר בפפואסיה, מונוגרפיה על צמחי הסוג מיריסטיקה, מונוגרפיה על אגוז המוסקט ומונוגרפיות של מחלות צמחים טרופיות שונות. פרסם ספר על עולם הצמחים בשלשה חלקים והוציא במשך 25 שנים את העתון „הנוטע הטרופי".

הוא התחיל בשנת 1904 להתענין בארץ־ישראל ונבחר לבסוף כראש ההנהלה הציונית בשנת 1911. התפטר ממשרתו זו בשנת 1919. היה אחד ממיסדי תחנת הנסיון החקלאות של ההנהלה הציונית ולבסוף יצר את המחלקה הבוטנית בירושלים.

עתון לבוטניקה

כרך ב׳ חוב׳ א׳ | סדרת רחבות | אלול תרצ״ח

ה„עתון לבוטניקה״ מופיע בשתי סדרות: סדרת רחבות וסדרת ירושלים.

סדרת רחבות היא הַמשכן של „רשימות לבוטניקה ולמדעי הגננות״, שנוסדו ע״י ה. ר. אופנהיימר בשנת 1935. סדרה זו יוצאת מעתה לאור ע״י ה. ר. אופנהיימר וי. ריכרט מהתחנה לחקר החקלאות שברחבות ומשמשת בטאון לבוטניקה טהורה ושמושית. שתי חוברות תופענה בשנה.

סדרת ירושלים יוצאת לאור ע״י חבר העובדים של המחלקה לבוטניקה באוניברסיטה העברית (המנהל: ד״ר א. איג). סדרה זו נועדה במיוחד לשמש בטאון למחקרים בוטניים רגיונליים של ארצות המזרח הקרוב. 4 חוברות תופענה בשנה.

העתון נועד בעיקר להחזקת הקשרים ולחלופי ידיעות עם העולם הבוטני שמחוץ לארץ.

לכל מאמר ינתן סכום קצר בעברית.

אחרי שנמסרה חוברת זו לדפוס, נפגע המדע הבוטני בארץ קשות על ידי מותו של הפרופ. אלכסנדר איג, חוקר הצמחים הידוע של האוניברסיטה העברית בירושלים. אי אפשר לנו לדאבוננו לתת עוד בגליון זה הערכה של עבודתו המדעית החשובה של המנוח. נעשה זאת בחוברת הבאה. גדולה האבדה!

כרך שני זה של סדרת רחבות

מוקדש לזכרו של

אוטו ורבורג

הבוטניקן הגדול

ואחד ממיסדיה של
התחנה לחקר החקלאות ברחבות

עתון לבוטניקה

מופיע בשתי סדרות

א. סדרת רחבות:
יוצאת לאור ע"י ה. ר. אופנהימר וי. ריכרט של התחנה לחקר החקלאות, רחבות, א"י. בכל שנה מופיעות 2 חוברות וכל חוברת נושאת עליה את תאריך הופעתה. כל כרך שנתי מכיל מ־200 עד 250 עמודים.

ב. סדרת ירושלים:
יוצאת לאור ע"י חבר העובדים של המחלקה לבוטניקה באוניברסיטה העברית ירושלים (המנהל: ד"ר א. איג). בכל שנה מופיעות 4 חוברות וכל חוברת נושאת עליה את תאריך הופעתה. כל כרך שנתי מכיל מ־300 עד 400 עמודים.

*

את דמי החתימה יש לשלם למפרע ע"י שק או המחאת דואר לפי הכתובת: המנהלה של העתון לבוטניקה, ת. ד. 620, ירושלים. מחיר החתימה הוא:

1,250 לא"י לשנה, בעד שתי הסדרות
0,600 לא"י לשנה, בעד סדרת רחבות בלבד
0,900 לא"י לשנה, בעד סדרת ירושלים בלבד
בסכום זה נכללים גם דמי המשלוח.
(מחיר חוברת בודדת 0,300 לא"י ושל כפולה 0,600 לא"י)

*

במכתבים הנוגעים לעניני המערכת של סדרת רחבות יש לפנות ל־„עתון לבוטניקה", ת. ד. 15, רחבות – ולעניני המערכת של סדרת ירושלים ל־„עתון לבוטניקה", ת. ד. 620, ירושלים.

*

במכתבים עסקיים, בכלל זה הודעה על שנוי כתובת, מודעות וכו', יש לפנות למנהלת העתון לבוטניקה ת. ד. 620, ירושלים.

תכן של חוברת ב'

שתצא לאור בטבת תרצ"ט

דפוס מ. שהם, תל־אביב, טלפון 2239

סדרת רחבות כרך ב׳ חוב׳ א׳ אלול תרצ״ח

עתון לבוטניקה

סדרת רחבות

(לפנים רשימות לבוטניקה ומדעי גננות)

יוצא לאור על ידי

ה. ר. אופנהימר וי. ריכרט

התחנה לחקר החקלאות, רחבות

תכן

עמוד

מוקדש לזכרו של פרופ׳ אוטו ורבורג

רחבות